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Water Quality Control Plan

San Francisco Bay Basin
California

Abstract



FOREWORD

This abstract presents key elements and summarizes the Water Quality Control Plan for the San Francisco Bay Basin of California. The purpose of the abstract is to provide background to further public participation in public hearings on the Plan. After evaluation in public hearings the Plan will be adopted by the San Francisco Bay Regional Water Quality Control Board (Regional Board) and approved by the State Water Resources Control Board (State Board). Final approval is required from the U.S. Environmental Protection Agency.

Public hearings and plan adoption are final steps in a three year study program that has been conducted in each of the 16 watershed planning

basins within the State. Each Basin Plan has been prepared in accordance with requirements of California's Porter-Cologne Water Quality Control Act and the Federal Water Pollution Control Act Amendments of 1972, commonly known as Public Law 92-500.

Public participation is encouraged during the hearings. Successful development and implementation of the recommended plans will depend in part on such public participation and support. The Porter-Cologne Water Quality Control Act requires public hearings before the adoption of the Plans, and furthermore requires the Regional and State Boards to consider all comments offered.

CALIFORNIA

Ronald Reagan, Governor

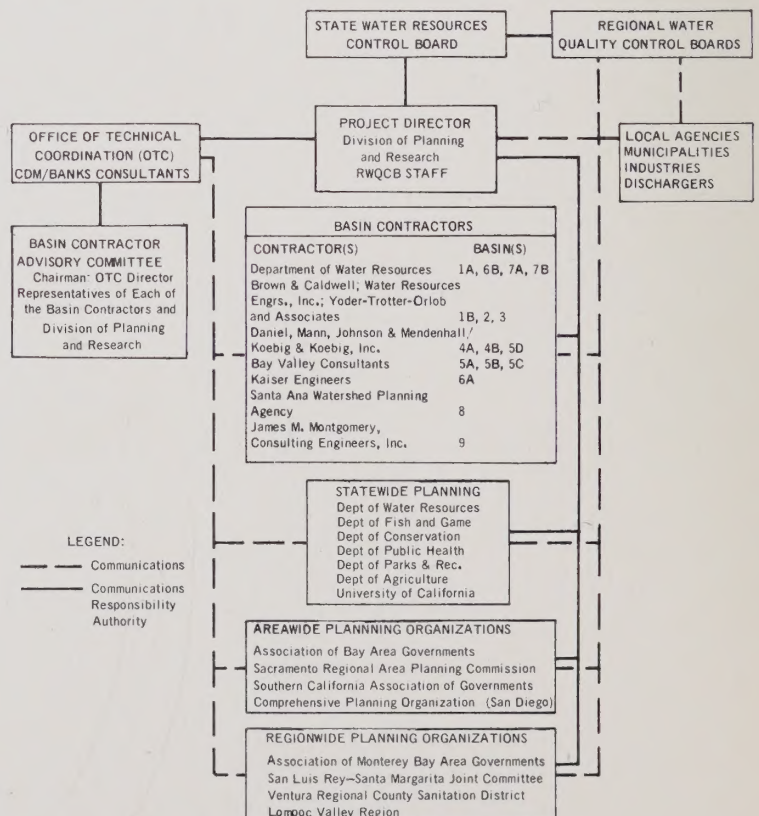


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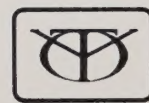
PROJECT MANAGEMENT CALIFORNIA WATER QUALITY CONTROL PLANNING



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**WATER QUALITY CONTROL PLAN
SAN FRANCISCO BAY BASIN (2)**

Abstract

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WATER QUALITY CONTROL PLAN

Abstract

THE PLANNING FRAMEWORK

This abstract presents key elements and summarizes the Water Quality Control Plan for the San Francisco Bay Basin of California. The purpose of the abstract is to provide background to further public participation in public hearings on the Plan. After evaluation in public hearings the Plan will be adopted by the San Francisco Bay Regional Water Quality Control Board (Regional Board) and approved by the State Water Resources Control Board (State Board). Final approval is required from the U.S. Environmental Protection Agency.

Goals, Objectives and Scope of Plan

While California is endowed with more water of good quality than many regions of the nation, the compound effect of increased use of water and increasing volume and strength of municipal, industrial and agricultural wastes have degraded or threatened water quality in many areas of the state. In San Francisco Bay, for example, dissolved oxygen levels in the southern extremities of the system are depressed considerably below natural values; shellfish harvesting has all but been eliminated within the Bay, and recreational uses along the bayshore of the San Francisco Peninsula are not permitted during portions of the year due to bacteriological contamination from untreated wet weather discharges.

Mitigation of these problems, plus the overall demand for a clean environment, requires a basin-wide water quality control and water resource management plan that provides for adequate protection of water resources in order to assure preservation of beneficial uses for enjoyment of present and future generations of Californians.

Most specific cases of pollution in the State are being corrected through enforcement actions by Regional Water Quality Control Boards. An effective water quality control program, however, cannot be based solely on enforcement; it must be comprehensive, taking into account the many factors which have direct and indirect bearing on water quality. The Plan must also have direction

and purpose. Development of comprehensive water quality plans in each basin of the State is essential to this type of program.

Future attempts to control water quality must be based on factors more omnibus than consideration of municipal and industrial wastewater treatment alone. Basin planning differs from similar studies of the past in that an attempt is made to assess the effect on water quality from a much broader range of man's activities.

The basic purpose of the State Board's basin planning effort is to ascertain future direction of water quality control management for protection of California's waters. Development of these plans will satisfy four objectives as follows:

1. Plans are a requirement of the U.S. Environmental Protection Agency in allocation of federal grants to cities and districts for construction of wastewater treatment facilities.
2. Plans will fulfill requirements of the Porter-Cologne Act that call for water quality control plans in California.
3. Plans will provide a basis for establishing priorities in the disbursement of both state and federal grants for construction and upgrading of wastewater treatment facilities.
4. Plans, by delineating water quality objectives to be achieved and maintained, will provide a basis for establishment or revision of waste discharge requirements by the Regional Board.

The Basin Plan is unabridged in scope. Historical, present and potential beneficial uses of surface and ground waters within the Bay Basin were identified, and water quality objectives necessary to protect these beneficial uses were established. The objectives became the technical goals of the plan and different control strategies were devel-

oped to meet them; policy and new legislation necessary to implement plans were also developed for consideration.

Planning Program Organization

The State Board's Division of Planning and Research in conjunction with the Regional Boards has organized and directed the statewide basin planning program. Planning areas were initially delineated in accordance with natural hydrographic boundaries as illustrated on the inside back cover of this abstract. A total of 16 study basins were defined within the nine administrative Regional Boards.

The water quality control study for San Francisco Basin is being conducted under contract with the State Water Resources Control Board, by Brown and Caldwell, Water Resources Engineers, Inc., and Yoder-Trotter-Orlob & Associates, a joint venture consortium. Input to the planning effort has been made by various state agencies as well as county and local agencies, by the Association of Bay Area Governments, and the Bay Area Sewage Services Agency. An Office of Technical Coordination (OTC) was established by contract with the State Board to provide technical criteria, coordination and standardization to the basin planning program. OTC has reviewed the plans for technical content and maintained statewide coordination.

Policies and Guidelines

Federal and State laws plus local policies have been enacted which establish requirements for adequate planning, implementation, management and enforcement, including penalties for noncompliance with water quality control measures. In addition, federal "regulations" and state "regulations and plans" have been developed to augment and clarify the laws and to provide detail not included in the law.

Regulations and plans adopted by the authoritative governmental body have legal stature and are enforceable whereas federal "guidelines" and State "policies" express the intent of the governing body. Although not legally enforceable, guidelines and policy establish mandatory constraints on Basin Plans and otherwise set forth firm direction that should be followed to achieve the goals expressed in the laws. These documents are generally concerned with implementation of the intent of the law.

State Board guidelines and policies were disseminated to basin contractors in the form of Management Memoranda. Coordination with the Regional Board, areawide planning organizations, and local and county governments resulted in the incorporation of pertinent policy and regulations from these agencies.

Planning Basis

To insure viability of the Basin Plan it is necessary to be cognizant of the many sub-regional and local plans within San Francisco Bay Basin. Such an awareness encourages coordination and exchange of information. Moreover, as most water quantity and quality problems discussed in the Basin Plan are subregional in extent, recommended programs will utilize existing institutions for their implementation and management.

Many local agencies and sewerage districts have formed joint powers agreements within subregions of the Basin and the status of their planning effort is reviewed and assessed in the preparation of the comprehensive water quality control plan. Upon establishment of base conditions and identification of goals, the planning program was shaped to meet these constraints in light of economic, land use, employment and population projections.

It is essential for comprehensive water quality management planning that estimates be made of future water demands and waste loads expected to occur in the basin. These estimates are based in part upon estimated future population and projected economic development. The type and extent of economic development depends upon location of resources within the basin such as productive land, potable water supply and many other industry specific resources. These important inputs were assessed and utilized to predict future water demands and waste loads.

Population projections were provided at the county level by the State Department of Finance for "E-0" and "D-150" population growth assumptions. Disaggregation of population projections and other related data (including land use and economic development) among the Hydrographic Subunits, the basic planning unit in Basin 2, was performed by the Association of Bay Area Governments.

One important aspect which was acknowledged in the formulation of the water quality control plan

for San Francisco Bay Basin is the dynamic nature of demographic and economic data. The recommended plan incorporates a significant degree of flexibility to accommodate unforeseeable future conditions resulting from technological advances and social mobility.

The Basin Plan was also established within the context of past regional, subregional and local wastewater management concepts. Subregional studies which have encompassed almost all portions of the Basin provided a sound data base and alternative program framework from which to develop basin-wide projects. Likewise the San Francisco Bay-Delta Water Quality Control Program of the late 1960's established a firm area-wide planning approach to comprehensive wastewater management used in this basin planning process.

Public Participation

Public participation has, in recent years, become a major input to planning both public and private facilities and establishing effective policies. Planners can develop technically, financially and ecologically sound plans, but it remains for the public to consider and select the most acceptable alternative. Early and continuing public participation allows for better understanding and the development of more effective plans. Full public involvement results in maximum awareness and support which aids in the implementation of the recommended plan.

As directed by the State Board, public meetings were held during the planning program by the Regional Board and the basin contractor. Introductory meetings informed the public of conceptual approach, objectives and goals of the Basin Plan. Population projections, identified beneficial uses, and water quality objectives were explained in subsequent public forums. The final workshop meeting was devoted to five alternative planning strategies which were compared on the basis of their ability to meet water quality objectives, economic and functional factors, and their potential impact on Basin environment. Citizens provided valuable input in the latter meetings when alternative planning strategies and selection of most viable Basin projects were presented for evaluation. The Basin Plan will be the subject of public hearings in January where further public comments on the final recommendations will be received. Following these hearings the San Francisco Bay Regional Board will adopt the Plan with

appropriate amendments depending on comments received. Following Regional Board adoption the State Water Resources Control Board will hold an approval hearing and adopt the plan together with appropriate amendments or conditions. The approved, adopted Water Quality Control Plan will then be forwarded to the Environmental Protection Agency in conformance with the requirements of Public Law 92-500.

THE BASIN

Planning for development of a basin-wide comprehensive water quality management program requires an awareness of the physical setting of the area under consideration. In the planning process, therefore, it is essential to be cognizant of the natural environment as well as the direct effect of resident population, land use and industrial development. The intent of this section is to briefly describe these characteristics and present data required for the conception and development of basin water quality control plans.

Geographic Setting

San Francisco Bay Basin is endowed with a unique geographic setting. Located on the central coast of California, it functions as the only drainage outlet for waters of the four Central Valley basins draining the western slopes of the Sierra Nevadas, and also marks a natural topographic separation between the northern and southern coast ranges. The Bay Basin's largest dimensions are 130 miles in length and 60 miles in width; it occupies about 4,300 square miles of land, 450 square miles of water surfaces and over 110 miles of California coastline as shown in Figure 1.

Topography

Long mountain ridges, characteristic of the Bay Area, form part of the Coast Range, a series of geologically youthful mountains, ranges and major valleys. Extending some 600 miles from Eureka to Santa Barbara, the Coast Ranges form a nearly continuous north-south barrier between the Pacific Ocean and the Central Valley. The Golden Gate provides the only break in these parallel ridges which rise to 4,000 feet in some locations.

Within the confines of the San Francisco Bay system, seaward of Chippis Island, there are 80 separate drainage basins having a total area of about 3,465 square miles exclusive of the bay

islands. The seven largest drainage basins comprise about 58 percent of the total. In decreasing order of size, these basins are: Alameda Creek, Napa River, Coyote Creek, Sonoma Creek, Guadalupe River, Petaluma River and Pacheco Creek.

Climate

Due to its location along the coast, the Bay Region experiences what is essentially classified as a maritime climate. Temperatures are mild in both summer and winter while precipitation occurs commonly during the months of October through April. The varied topography produces a variety of local climatic conditions in terms of temperature, rainfall and exposure to wind and fog. Indeed, annual rainfall varies from 12 inches per year in the eastern portion of Alameda County to 50 inches per year in the mountains of Santa Clara and Sonoma counties.

In addition to the topographic characteristics, climatic conditions determine, to a large extent, the susceptibility of an area to air quality degradation. As in other coastal regions of the State, subsidence inversions dominate over the Basin most of the year forming an effective barrier against vertical interchange of air and the upward dispersion of air pollutants.

The bottom of the inversion layer varies seasonally and daily between 1,000 and 3,000 feet in elevation. Due to solar heating, the inversion usually breaks up initially near the extreme ends of the Sonoma and Santa Clara valleys. Wide variations in vertical mixing are also experienced in these areas. Except for early fall, late September and October, and during periods of high temperatures in April, May or June, wind circulation patterns usually provide sufficient ventilation in much of the Bay Area.

Geology

Geologic forces that formed San Francisco Bay in late Pliocene time still exist today. Geologic formations which commonly form the older bedrock complex are comprised of sedimentary, igneous and metamorphic rocks of the Franciscan Group. The geologic structure is continually changing as evidenced by crustal movement and the high degree of faulting and shearing in the Franciscan Formation.

Major earthquake activity has centered along the San Andreas Fault zone, including the great San

Francisco earthquake of 1906. Since that earthquake, there have been four earthquakes of magnitude 5.0 (Richter scale) or greater in the Basin. The San Andreas fault remains fairly active with evidence of recent slippage along the fault.

Mineral Resources

Economically available mineral resources are abundant in San Francisco Bay Basin contributing to the region's economic growth. Construction materials such as sand, gravel and rock are located in many areas and are the major mineral resources with over 20 million tons mined in 1965. Salt and other salines have been extracted from Bay waters since 1862 and, together with the construction materials, constitute 95 percent of the mineral commodities produced. Natural gas and petroleum are obtained from a few areas while mercury mines in the Basin have been among the nation's principal producers.

Fish and Wildlife Resources

The San Francisco Bay system is the most extensive and in many ways the most significant estuary on the California coast. Deepwater channels, tidelands, marshlands, freshwater streams, and rivers of the system provide a variety of habitats which have become much more vital with the reduction in size and loss to development of other estuaries in the State. Myriads of fish and wildlife species utilize Bay habitats for feeding and nursery grounds. The Bay system also provides a migratory pathway for anadromous fish and is a key stopping point for migratory birds on the Pacific Coast Flyway.

The unusual physical characteristics of the Bay system contribute to the diversity of habitat within it. Deepwater areas exist within each segment of the Bay adjacent to large expanses of very shallow water. A wide salinity range from hypersaline to freshwater is nearly always present and wide ranges of water temperature are also encountered. This situation greatly increases the number of species which can live in the Bay and therefore enhances its biological stability.

The anadromous fishes are commonly considered to be the most important group of fishes in the Bay system. They include the striped bass, chinook and coho salmon, steelhead, two species of sturgeon and American shad. These fish spend most of their lives in the open ocean but depend on freshwater streams and rivers as spawning



Figure 1. San Francisco Bay Basin



grounds. Juvenile striped bass make extensive use of the highly productive shallow water margins of the Bay system as feeding grounds.

Despite the fact that coldwater habitat in the Basin has been greatly reduced over the previous two decades, rainbow trout and other salmonid species continue to support a significant recreational fishery of approximately 450,000 angler days annually. Self-sustaining trout populations are generally limited to the headwaters of unmodified streams. Many warmwater reservoirs and streams are stocked with catchable size trout which do not reproduce and must be replaced annually.

Both softshell and littleneck clams occur in the intertidal zone of San Francisco Bay in sufficient numbers to be considered potentially harvestable. Other clams found in much lower numbers include the gaper clam, the native littleneck clam, the bentnosed clam, the basket cockle, the Washington clam, and the quahog. Once harvested commercially in the Bay, both Eastern and Pacific oysters are still abundant. Ribbed horsemussels are abundant in the lower portion of the Bay and bay mussels are common throughout the system.

The Bay system is considered essential as a nesting place, feeding area and wintering ground on

the Pacific Flyway; there are over 75 species of aquatic birds which either reside in or are regular visitors to the system. Most of the waterfowl using the Bay are ducks. Of these, 92 percent are puddle ducks, which feed on shallow water vegetation, particularly alkali bulrush. The remaining 8 percent are diving ducks which feed on the invertebrate fauna of deeper waters.

Population, Land Use and Economy

As in many metropolitan areas population and economic growth are the result of various interacting forces. Expansion and diversification of national and international markets, for example, give rise to new as well as existing employment opportunities which attract additional people to the area and often effect local resident densities.

Growth and economic well-being of residential, commercial and particularly industrial activity is strongly related to the availability of adequate and economical sources of water supply, energy and other services rendered by the metropolitan infrastructure. Historically, these demands have been supplied with economical fresh water supplies from outside the Basin, readily available cooling water from bay and estuary, and energy in the forms of gas and electrical power furnished by facilities of the Pacific Gas and Electric Company.

Population

Projections of future population and its special distribution is a major concern in the development of a comprehensive water quality control plan. Population projections were prepared by Association of Bay Area Governments (ABAG) employing State Department of Finance figures available at the county level. The Department of Finance (DOF) forecasts population by making assumptions regarding natural population changes and net in-migration for each basin of the State and for each county within individual basins. The lower E-0 projection combines an assumed fertility rate of 2.11 births per woman with a net migration of zero for the State through year 2000. Department of Finance projection D-150 assumes a fertility rate of 2.45 and a net in-migration to the State increasing from a low of 29,000 in 1969-70 to 150,000 by 1980 and remaining constant through year 2000.

Because a major portion of the Bay Area is located within a critical air basin (as defined by the

State Air Resources Board), two population projections, namely the E-0 and D-150 series, have been used in planning. Sensitivity of alternative planning strategies to higher than D-150 level populations was also assessed; analysis was based on local subregional growth data rather than DOF information for these demographic maxima.

Elements of the recommended plan were designed for "baseline" population projections, a combination of the two sets of population forecasts by DOF and local projections in the case of Marin County and the Petaluma HSU. For this projection, growth in the five southern counties was restricted to E-0 projection due to air quality limitations while the remaining counties (Marin, Napa, Solano and Sonoma) were assigned future

populations consistent with D-150 or local projections as summarized in Table 1.

Comparative population projections are shown in Figure 2. Basin Plan projections together with forecasts made by ABAG and a composite of populations used in the subregional reports are described. Most apparent is the fact that subregional composite projections exceed other forecasts. In the past, local planning agencies tended to assume nearly complete utilization of their developable lands and did not balance their growth projections against State and regional demographic expectations. Subregional study population data thus provided a basis for evaluation of alternative plan sensitivity to accelerated rates of population growth.

Table 1. Population Projections by County^a

County	Projection level	1970	1980	1990	2000
Alameda	E-O, Baseline	1,076	1,148	1,221	1,274
	D-150	1,076	1,218	1,381	1,510
Contra Costa	E-O, Baseline	559	650	731	791
	D-150	559	689	850	986
Marin ^b	E-O	207	243	284	322
	Baseline	207	260	300	340
	D-150	207	261	336	404
Napa	E-O	79	96	113	126
	Baseline, D-150	79	102	146	191
San Francisco	E-O, Baseline	714	712	706	689
	D-150	714	722	730	726
San Mateo	E-O, Baseline	556	572	582	574
	D-150	556	613	678	720
Santa Clara	E-O, Baseline	1,042	1,271	1,508	1,636
	D-150	1,042	1,349	1,762	1,910
Solano	E-O	135	167	201	239
	Baseline, D-150	135	168	230	334
Sonoma ^b	E-O	58	77	93	106
	Baseline	58	73	97	133
	D-150	58	85	113	145
Basin Total	E-O	4,444	4,936	5,439	5,757
	Baseline	4,444	4,956	5,521	5,962
	D-150	4,444	5,207	6,226	9,926

^a Population in thousands

^b Baseline projections based on local population projections.

Land Use

The nine county San Francisco Bay Region covers 4.5 million land acres, of which 2.7 million acres, or 60 percent are in Basin 2. There is an additional 200 thousand acres of water surface comprising 7 to 8 percent of the Basin's areal extent. Present land use acreages in the Basin are summarized in Table 2 together with land use changes forecasted by ABAG's 1970 to 1990 Regional Plan.

Economy

Population growth in the Bay Basin is, to a large extent, contingent upon potential economic development. Such development has in the past provided stimulus for higher levels of employment which, in turn, have resulted in growth in resident populations. Employment projections developed by ABAG also form the foundation for employment data used to estimate future waste loads from the industrial sector.

Employment projections for the Basin, as shown in Table 3, indicate an increase in employment from 1.9 million to 3.2 million over the next 30-year period. Growth in manufacturing employ-

ment appear greatest, resulting in an increase of 135 percent by year 2000.

A summary of annual production growth rates in six basic industrial categories considered is presented in Table 4. Those areas expected to experience the most rapid growth in industrial production are the eastern and northern counties. More conservative estimates of increases in production are predicted for the western counties while reductions in the level of industrial production are anticipated for the City and County of San Francisco.

Water Resources Development and Use

Present water supplies within the Bay Basin are, for the most part, imported from neighboring basins to the east and north as shown in Figure 3. A potential exists for additional water supply from the Central Basin via the Bureau of Reclamation's San Felipe Project. Groundwaters contribute only a fraction of the total water supply in the Basin, satisfying less than 1 percent of the domestic water demand. Several groundwater basins are used as storage reservoirs for imported supplies.

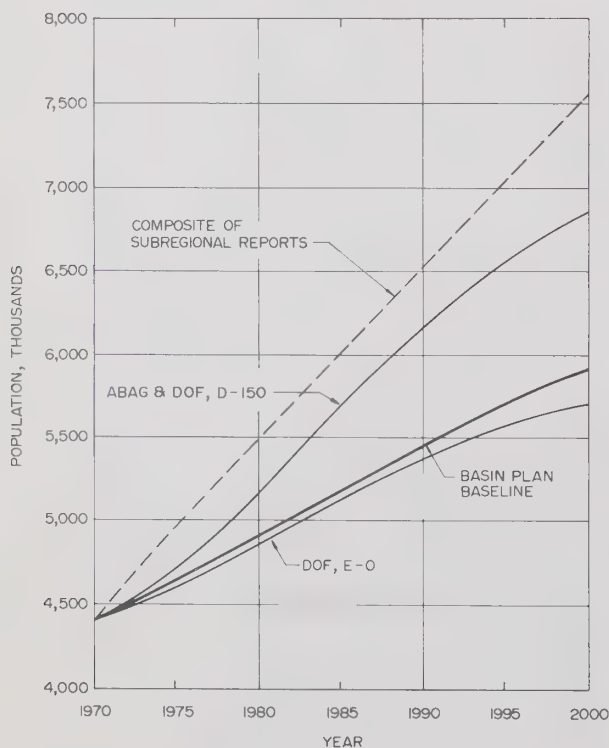


Figure 2. Comparative Population Projections



Table 2. Projected Land Use

County ^b	Year	Land area, thousand acres ^c							
		Residential	Commercial	Industrial	Net irrigated	Irrigable remaining	Remaining non-irrigable suitable for urban use	Remaining	Total
San Francisco	1970	13.2	2.7	4.0	-	-	1.2	8.9	30.1
	1975	13.2	2.9	4.3	-	-	0.9	8.7	
	1980	13.2	3.1	4.5	-	-	0.7	8.6	
	1990	13.2	3.2	4.8	-	-	0.4	8.6	
	2000	13.1	3.3	5.2	-	-	-	8.6	
San Mateo	1970	39.0	7.3	6.7	2.9	21.3	28.8	224.1	305.9
	1975	44.1	8.1	7.7	2.6	21.1	22.5	223.4	
	1980	51.8	8.8	8.7	2.9	20.4	14.4	222.3	
	1990	63.5	9.2	10.1	2.4	17.7	2.7	220.3	
	2000	67.9	9.8	11.7	2.0	15.3	1.7	214.7	
Alameda	1970	63.5	6.2	17.0	11.5	73.9	38.3	280.8	405.7
	1975	72.6	7.4	19.4	9.2	65.8	26.7	276.6	
	1980	84.0	8.2	21.6	7.3	57.0	14.1	278.0	
	1990	91.1	9.8	25.7	5.0	50.9	3.4	275.7	
	2000	101.2	12.3	28.4	3.7	38.6	0	263.9	
Santa Clara	1970	66.7	23.0	24.5	37.8	101.6	44.7	431.0	589.9
	1975	80.0	24.6	26.5	33.3	89.0	29.4	429.5	
	1980	93.2	27.9	25.3	29.3	78.1	15.8	427.6	
	1990	99.2	24.6	29.1	22.0	76.5	9.4	427.6	
	2000	124.4	23.5	31.9	16.2	55.7	10.9	399.2	
Contra Costa	1970	53.6	8.7	21.0	32.8	99.0	90.1	249.2	422.7
	1975	65.8	9.1	22.2	31.3	88.8	76.5	249.0	
	1980	82.7	9.3	23.0	30.1	74.2	59.5	248.2	
	1990	99.6	9.0	24.2	29.1	62.3	12.5	277.4	
	2000	130.7	8.6	24.9	28.8	43.1	13.5	245.1	
Solano	1970	5.9	0.3	6.7	12.0	65.5	10.3	185.6	208.8
	1975	7.0	0.9	6.9	13.0	64.3	8.6	185.4	
	1980	8.2	1.5	7.0	14.0	62.9	6.9	185.3	
	1990	10.1	2.5	7.1	14.5	61.2	4.2	185.0	
	2000	22.0	3.6	7.3	15.0	52.4	8.6	167.3	
Marin	1970	20.2	1.8	1.1	1.0	20.0	27.3	258.5	309.1
	1975	21.7	2.0	1.5	1.0	20.0	25.4	258.4	
	1980	25.3	2.2	1.9	0.9	19.8	21.4	258.4	
	1990	35.9	2.6	2.8	0.7	19.7	10.8	257.1	
	2000	41.2	2.8	3.6	0.6	19.6	13.9	247.6	
Sonoma	1970	4.6	.2	.8	4.5	94.7	10.7	148.9	165.2
	1975	5.1	.3	1.2	5.7	92.8	9.8	148.7	
	1980	6.3	.4	1.6	6.6	90.5	8.3	148.5	
	1990	14.0	.7	2.6	8.5	83.7	3.5	147.4	
	2000	14.1	.9	3.5	11.5	76.7	3.9	142.8	
Napa	1970	6.5	1.5	1.5	7.0	80.0	15.8	247.2	272.6
	1975	8.1	1.7	2.0	8.0	76.9	13.5	247.2	
	1980	10.7	1.9	2.5	10.0	71.9	10.4	247.1	
	1990	17.7	2.1	3.5	19.7	53.4	3.1	246.2	
	2000	24.2	2.2	4.4	22.0	45.5	5.3	236.6	

^a Land use data summarized by County. Land use data for Hydrographic Subunits is given in Task Report III-1,

^b Portions of counties within Basin 2.

^c Land use categories are defined as follows:

Residential - Gross acreage in residential use, including single and multiple dwelling units and roads and streets.

Commercial - Gross acreage occupied by local-serving establishments, including shopping centers, strip commercial and central business districts. Also included are roads and streets.

Industrial - Gross acreage occupied by establishments in basic industries, including manufacturing, wholesale trade, transportation and utilities plus roads and streets.

Net Irrigated - Acreage defined as any agricultural land on which water is applied to grow crops.

Irrigable Remaining - Acreage defined as all vacant land under 25 to 30 percent slope with effective rooting depth of roughly one foot or more.

Remaining Non-irrigable - Gross acreage suitable for urban purposes but not suitable for irrigated agriculture, including industrial available, other available, and noninfrastructure vacant.

Remaining - Difference between total land and the sum of residential, commercial, industrial, and remaining non-irrigable suitable for urban development.

Table 3. Distribution of Projected Employment^a

County	Employment type	1970	1975	1980	1990	2000
San Francisco	Commercial	440,849	459,089	472,125	502,778	571,762
	Light industrial	30,949	33,213	33,687	33,347	34,019
	Heavy industrial	26,683	25,264	24,024	21,992	20,456
Marin	Commercial	47,120	57,093	66,074	83,882	107,897
	Light industrial	2,479	2,881	3,309	4,208	5,565
	Heavy industrial	1,098	1,138	1,161	1,206	1,261
San Mateo	Commercial	185,949	203,930	219,488	246,457	297,836
	Light industrial	20,851	26,268	30,903	39,952	56,687
	Heavy industrial	9,816	10,250	10,712	11,281	12,770
Sonoma	Commercial	12,398	19,793	26,732	40,204	56,654
	Light industrial	904	1,075	1,256	1,665	2,270
	Heavy industrial	754	861	985	1,276	1,726
Napa	Commercial	23,144	37,536	51,197	77,881	110,668
	Light industrial	1,314	1,470	1,589	1,828	2,221
	Heavy industrial	1,159	1,268	1,346	1,510	1,705
Solano	Commercial	39,389	57,881	75,669	111,369	153,751
	Light industrial	600	1,169	1,256	1,444	1,705
	Heavy industrial	2,758	2,923	3,119	3,607	4,294
Contra Costa	Commercial	112,394	132,120	149,792	184,069	231,524
	Light industrial	6,663	9,040	10,338	13,555	18,957
	Heavy industrial	17,864	18,380	19,583	22,432	26,243
Santa Clara	Commercial	297,729	319,658	336,919	376,387	448,467
	Light industrial	94,163	108,532	120,436	141,993	169,434
	Heavy industrial	27,212	27,968	29,294	32,655	37,105
Alameda	Commercial	356,274	375,249	397,288	394,928	486,956
	Light industrial	40,935	49,631	54,274	93,709	84,244
	Heavy industrial	60,238	63,504	67,061	75,101	84,572
Basin subtotal	Commercial	1,515,235	1,662,349	1,789,284	2,017,955	2,465,515
	Light industrial	198,858	233,279	257,548	331,701	375,102
	Heavy industrial	147,202	151,556	157,181	171,497	190,132
Total employed in Basin 2		1,861,295	2,047,184	2,204,013	2,521,153	3,030,749

Future water supply demands are expected to be met by reliance on both present sources of supply and development of supplemental supplies from outside the Basin. Currently, the Marin Municipal Water District is seeking approval of the North Marin intertie and raising storage levels of Nicasio and Kent reservoirs. North Marin Water District is participating in construction of the Russian River-Cotati intertie scheduled for completion in 1977. This project will provide additional supplies for Sonoma County Water District as well. The Contra Costa Water District is implementing plans for a wastewater reclamation project in conjunction with the Central Contra Costa Sanitary District. By 1976, 35,000 acre-feet (30 mgd) of reclaimed wastewater will become available annually to

industry along the south shore of Suisun Bay, thereby relieving demand on the lower reach of the District's canal.

In 1967 the East Bay Municipal Water District staff recommended that the American River was the most feasible source of supplemental supply. Accordingly, the District Board of Directors has arranged with the Bureau of Reclamation to purchase additional water supplies from the American River; the new aqueduct, if water rights are favorably adjudicated, may convey 150,000 acre-ft per year. Alameda County Water District has embarked on a three-phase groundwater reclamation program. The District uses water from South Bay Aqueduct to reduce present demands on the

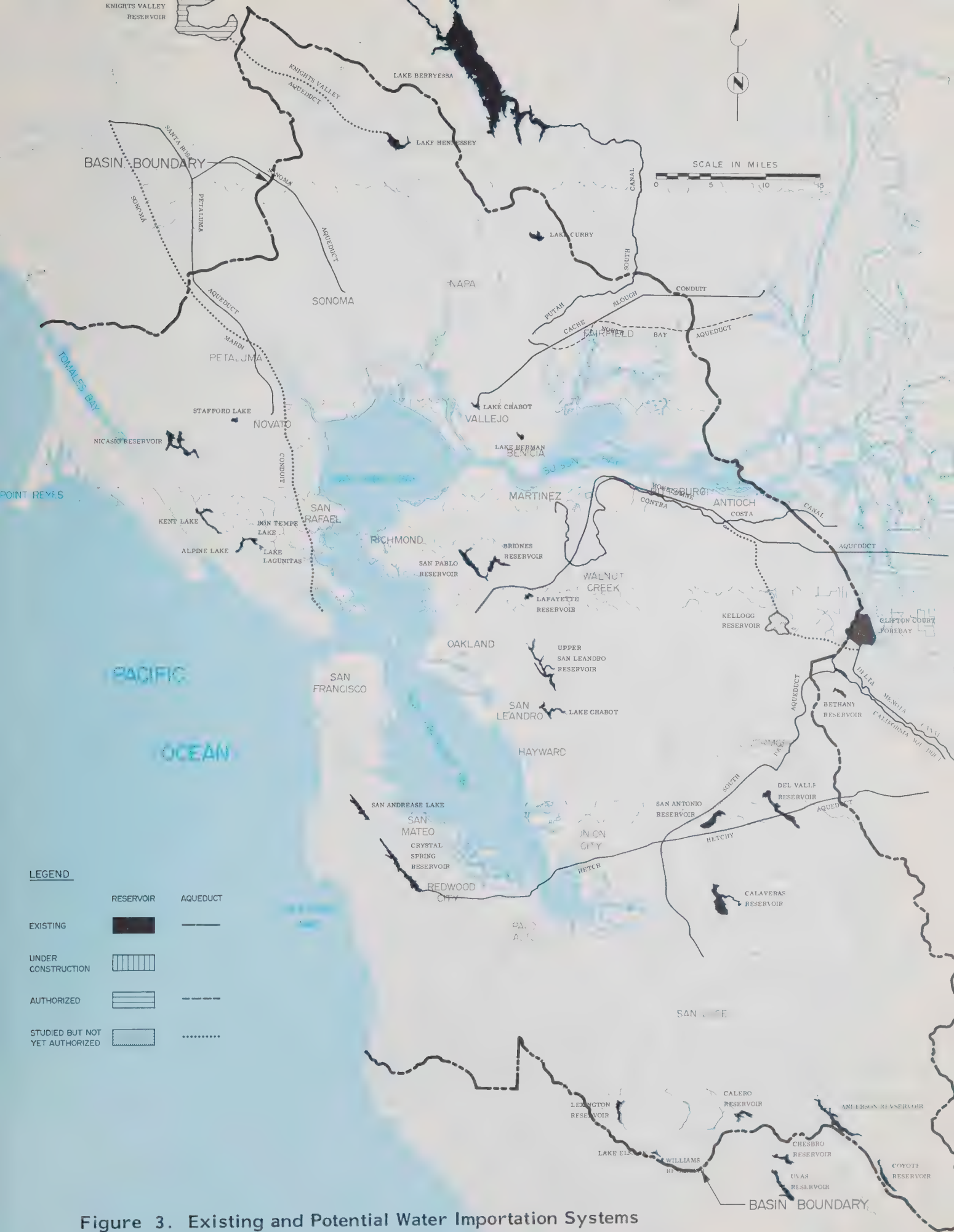


Figure 3. Existing and Potential Water Importation Systems

groundwater basin, to recharge the groundwater basin with good quality water while extracting saline water from intermediate or deeper aquifers, and in the future to construct a saline intrusion barrier near the bayshore. In an attempt to replenish groundwater overdrafts, Santa Clara Flood Control and Water District is negotiating with the Bureau of Reclamation for supplemental water from the Bureau's San Felipe Project. Supplemental water (approximately 140,000 acre-ft) could be conveyed north into Santa Clara County if negotiations are successful.

The San Francisco Water Department has annual rights to 450,000 acre-feet (400 mgd) from Tuolumne River flow. Through the Hetch Hetchy reservoir and aqueduct system, the Company supplies San Francisco, most of the Peninsula, parts of Alameda, and Santa Clara counties with a present capacity of 295 mgd. Plans for a fourth pipeline which would increase the capacity to 398 mgd are under consideration, but detailed projection as to when the additional capacity will be required has not been made.

A summary of total water resources and projected water demands for the Basin under baseline plan-

ning assumptions is presented in Table 5. These projections indicate that water available from local surface and groundwater supplies will remain essentially constant during the planning period, whereby increased quantities of imported water and greater emphasis on the reclamation of water must be made to accommodate projected demands.

Water Quantity and Quality Problems

The quantity and quality of water entering the Basin from outside sources and changes occurred through consumptive use have an important bearing on the resultant quality of water within the Bay system. The Basin Plan must identify as clearly as possible both present and potential water quality and quantity problems. The assessment of these problems and proposed solutions is necessary not only to insure that sufficient water of adequate quality is available for direct use, but also to insure that such use will not degrade receiving water quality to an extent that beneficial uses of water are adversely affected.

Inadequately controlled and treated waste materials have been a significant cause of many water



Briones Watershed in the East Bay

quality problems in the Bay Basin that presently exist. Waste materials have derived from diffuse sources such as surface runoff, stormwater systems, agricultural drainage and accidental spills as well as municipal and industrial waste discharges. Inadequate source control of persistent deleterious materials, especially those subject to biological concentration, allows toxic materials to enter the aquatic environment because most waste treatment systems remove only a fraction of such pollutants.

Water quality problems most common to water supply systems and inland surface waters originate from inadequate treatment systems and agricultural operations. The California Department of Health has expressed concern over septic tanks which discharge above Donner Creek and Lake Hennessey, and the quantities of dairy wastes that are discharged to the Petaluma River upstream from the City of Petaluma's domestic water supply intake. Concern with the discharge of dairy wastes into other streams in both Marin and Sonoma counties is also echoed by California Department of Fish and Game as agricultural wastes pose a threat to stream habitats and survival of fish.

The Napa and Petaluma Rivers as well as Sonoma Creek and Suisun Marsh have low assimilative capacity for oxygen demanding wastes. Dissolved

oxygen values have been observed well below water quality objectives in these segments of the Bay. Excessive growths of algae have also been observed.

Water quality problems which involve beneficial uses of the San Francisco Bay are of paramount concern. Present water quality problems that occur in various portions of the Bay involve oxygen depletion, biostimulants, toxicity, and oil or chemical spills.

Several areas exist in the Bay system, in addition to inflowing surface streams, where oxygen levels do not meet minimum standards set by the Regional Board. These areas include the South Bay below Dumbarton Bridge and sloughs with restricted circulation that receive waste inflow. Critical conditions for dissolved oxygen in the South Bay are associated with discharge of cannery wastes in August and September from municipal wastewater treatment facilities. However, dissolved oxygen levels are frequently depressed during the winter months due in part to oxygen demanding substances carried into receiving waters by stormwater runoff.

Areas of San Francisco Bay that experience problems with excessive algae growths include the upper end of Richardson Bay, shallow backwater portions of Suisun and San Pablo Bays, the Al-

Table 4. Existing and Projected Gross Industrial Output^a

County	SIC 20 Food		SIC 26 Paper		SIC 28 Chemicals		SIC 29 Petroleum		SIC 33 Primary metals		SIC 34 Metal fabrication	
	1970	2000	1970	2000	1970	2000	1970	2000	1970	2000	1970	2000
Alameda	840.5	1,242.8	128.4	236.4	234.3	501.3	29.0	39.0	249.9	274.0	742.0	2,187.0
Contra Costa	157.3	290.1	74.0	139.6	219.4	530.8	1,632.0	2,943.0	130.7	189.1	117.3	405.9
Marin	12.3	17.0	0.82	4.4	0	0	0	0	1.7	2.4	7.4	76.0
Napa	38.1	72.5	.86	7.5	0.1	0.2	0	0	34.6	245.4	2.9	20.8
San Francisco	715.2	1,073.5	64.3	133.3	82.4	188.3	29.0	29.0	32.8	37.5	250.1	812.6
San Mateo	158.9	202.6	30.5	119.7	122.2	269.2	0	0	116.3	156.3	150.8	809.0
Santa Clara	556.9	988.9	84.7	134.1	94.0	245.2	10.0	19.0	26.9	44.9	522.1	1,361.3
Solano	105.4	198.7	0.3	0.6	3.3	7.5	300.0	398.0	2.2	3.1	19.3	67.5
Sonoma	97.7	200.1	0	3.1	1.7	37.9	0	19.0	0.5	12.2	22.5	119.2
Basin total	2,682.3	4,286.2	383.9	779.0	757.4	1,780.4	2,000.0	3,447.0	595.6	964.8	1,834.4	4,859.3

^a Gross industrial output expressed in million dollars.

Table 5. Water Balance Summary^a

Subarea	Available supply	Projected demand ^b			Water balance
		1980	1990	2000	
North Bay	307 ^c	147.6	209.2	262.0	45 surplus in 2000
East Bay	809 ^d	485.2	547.5	618.6	190.4 surplus in 2000
South Bay	358 ^e	335.0	379.8	405.5	Demand projected to exceed supply between 1980 and 1990
Peninsula	274 ^f	221.1	229.9	234.7	39.3 surplus in 2000

^a Expressed in thousand acre-feet per year.

^b Includes projected demands from municipal, industrial, and agricultural users, except in eastern Contra Costa County where agricultural users have established independent supplies.

^c Capacities or allocation as of 1984, whichever is smaller.

^d Present available supplies.

^e Present available supplies.

^f Present available supplies.

bany tidal flats and the sloughs of South Bay. Algae concentrations greater than 4 million cells per liter have been observed in portions of the South Bay below Dumbarton Bridge and in Suisun Bay, while blooms of red pigmented ciliate, *Mesodinium rubrum*, and green algae have occurred in San Pablo Bay.

Premature death of aquatic organisms serves as an indication of sudden water quality changes. Fish kills occurring in the Bay have, in some instances, been traced to failures in wastewater treatment systems and the release of acutely toxic industrial wastes. Pesticides, found in waters throughout the Bay, originate from agricultural drainage, municipal storm and sanitary sewer systems, and urban runoff. Due to high absorption capability on particulate matter, several toxic heavy metals have become concentrated in sediments of portions of the Bay. Heavy metal concentrations in shellfish taken from several Bay areas are higher in many cases than levels recommended by public health officials.

Oil spills can also kill or contaminate fish, shrimp and bottom dwelling organisms such as oysters, clams, and abalones. Aquatic birds and mammals can be affected, and fish production lowered. In addition, fish flesh can become tainted in the

presence of very low concentrations of oil. Although wholesale loss of fish and wildlife have been infrequent in Bay waters, chronic effects associated with continuous discharge of petroleum products may be significant.

Two of the major groundwater basins in terms of storage capacity and safe yield within the study area have been subjected to serious overdraft in the past. They are found in the Santa Clara and Livermore Valleys. Overdraft of several subbasins within these groundwater systems has resulted in deteriorated water quality due to saline water intrusion from the Bay. Corrective measures have been implemented in recent years.

Most of the water quality problems that require solution in coming years presently exist, although some which are either of small magnitude or consequence may amplify. Such problems can increase due either to increased waste loads to specific receiving waters which cannot assimilate or disperse pollutants to acceptable levels or additional diversion of Delta inflow waters for transport south that may significantly modify present hydraulic regimes and possibly the physical-chemical characteristics of the Bay system. Other than accentuation of dissolved oxygen depletion, eutrophication and toxicity buildup, future prob-

lems may also be associated with temperature increases and changes in salinity. Bacteriological quality of the Bay, as indicated by coliform counts, may not improve unless additional controls are placed on wet weather overflows and storm runoff.

THE PLANNING PROCESS

The fundamental process involved in developing the recommended Basin Plan entails identification of beneficial uses of Basin waters requiring protection, establishing water quality objectives to assure protection and enable enhancement, and assessing resultant water quality conditions prior to the consideration of alternative wastewater management plans.

Beneficial Uses

Establishing beneficial uses of surface and groundwaters to be protected serves as an initial step in a basin planning process. Once beneficial water uses are identified, compatible water quality objectives are formulated as well as the level of treatment necessary to maintain objectives and ensure continuance of beneficial uses.

More than 100 individual receiving water bodies were studied in the planning process, representing the most comprehensive evaluation of beneficial uses in San Francisco Bay Basin to date. Inclusion of these water bodies and identification of beneficial uses was based on the knowledge and experience of the environmental study team as well as information obtained from the California Department of Fish and Game, the Department of Health and the Regional Board. Public comments received through workshop sessions early in the planning process were also incorporated in the final list of existing and potential beneficial uses.

Modifications, largely administrative in nature, to the list of beneficial uses result from the State Board's adoption from new designations which have been recommended for uniform statewide consideration of beneficial uses. Standard designations for beneficial uses for surface waters and groundwaters, as defined below, are applicable throughout California:

Municipal and Domestic Supply (MUN) — Includes usual uses in community or military water systems and domestic uses from individual water systems.

Agricultural Supply (AGR) — Includes crops, orchard and pasture irrigation, stock watering, support of vegetation for range grazing and all uses in support of farming and ranching operations.

Industrial Process Supply (PROC) — Includes process water supply and all uses related to the manufacturing of products.

Industrial Service Supply (IND) — Includes uses that do not depend primarily on water quality such as mining, cooling water supply, hydraulic conveyance, gravel washing, fire protection, and oil well repressurization.

Groundwater Recharge (GWR) — Natural or artificial recharge for future extraction for beneficial uses and to maintain salt balance or halt salt water intrusion into freshwater aquifers.

Navigation (NAV) — Includes commercial and naval shipping.

Hydropower Generation (POW) — Used for hydropower generation.

Water Contact Recreation (REC-1) — Includes all recreational uses involving actual body contact with water, such as swimming, wading, water skiing, skin diving, surfing, sport fishing, uses in therapeutic spas, and other uses where ingestion of water is reasonably possible.

Non-Contact Water Recreation (REC-2) — recreational uses that involve the presence of water but do not require contact with water, such as picnicking, sunbathing, hiking, beachcombing, camping, pleasure boating, tidepool and marine life study, hunting and aesthetic enjoyment in conjunction with the above activities as well as sightseeing.

Ocean Commercial and Sport Fishing (COMM) — The commercial collection of various types of fish and shellfish, including those taken for bait purposes, and sport fishing in oceans, bays, estuaries and similar nonfreshwater areas.

Warm Freshwater Habitat (WARM) — Provides a warm water habitat to sustain aquatic resources associated with a warm water environment.

Cold Freshwater Habitat (COLD) — Provides a cold water habitat to sustain aquatic resources associated with a cold water environment.

Preservation of Areas of Special Biological Significance (ASBS) — Areas of special biological significance are those areas designated by the State Water Resources Control Board as requiring protection of species or biological communities to the extent that alteration of natural water quality does not occur.

Saline Water Habitat (SAL) — Provides an inland saline water habitat for aquatic life resources. Soda Lake in the Central Coastal Basin is a saline habitat typical of desert lakes in inland sinks.

Wildlife Habitat (WILD) — Provides a water supply and vegetative habitat for the maintenance of wildlife.

Preservation of Rare and Endangered Species (RARE) — Provides an aquatic habitat necessary, at least in part, for the survival of certain species established as being rare and endangered species.

Marine Habitat (MAR) — Provides for the preservation of the marine ecosystem including the propagation and sustenance of fish, shellfish, marine mammals, waterfowl and vegetation such as kelp.

Fish Migration (MIGR) — Provides a migration route and temporary aquatic environment for anadromous or other fish species.

Fish Spawning (SPWN) — Provides a high quality aquatic habitat especially suitable for fish spawning.

Shellfish Harvesting (SHELL) — The collection of shellfish such as clams, oysters, abalone, shrimp, crab and lobster for either commercial or sport purposes.

State policy for water quality control in California is directed toward achieving the highest water quality consistent with maximum benefit to the people of the State. In keeping with this policy, all water resources must be protected from pollution and impairment that might occur as the result of waste discharge. Beneficial uses of surface waters, groundwaters, and coastal waters



Table 6. Existing and Potential Beneficial Uses of Surface Waters^a

SURFACE WATERS		MUN	AGR	IND	PROC	GWR	FRSH	NAV	POW	REC 1	REC 2	COMM	WARM	COLD	BIOL	SAL	WILD	RARE	MAR	MIGR	SPWN	SHELL
1	Merced Lake	○									●			●			●					
2	Crystal Springs Lakes	●									○		●	○			●	●				
3	San Mateo Creek						●			○				○			●	●				
4	Pilarcitos Lake	●									○				○		●	●				
5	Pilarcitos Creek	●								○	○			●			●	●		●	●	
6	San Andreas Lake	●									○		●	●	○		●	●				
7	San Vicente Creek									○	○			●			●	●		●	●	
8	Denniston Creek									○	●		●	●			●	●		●	●	
9	Frenchmans Creek		●							●	●			●			●	●		●	●	
10	Purisima Creek		●							●	●			●			●	●		●	●	
11	Lobitas Creek									●	●			●	○		●	●		●	●	
12	Tunitas Creek									○	○			●	○		●	●		●	●	
13	San Gregorio Creek									●	●		●	●			●	●		●	●	
14	Pescadero Creek									●	●			●	○		●	●		●	●	
15	Searsville Lake		●							●	●		●	●			●					
16	Felt Lake		●							●	●		●				●					
17	San Francisquito Creek									○	○		●	●			●			●	●	
18	Stevens Creek Reservoir	●				●					●		●	●			●			●	●	
19	Stevens Creek						●			●	●		●	●			●			●	○	
20	Calero Reservoir	●				●				●	●		●				●					
21	Almaden Reservoir	●				●				●			●				●					
22	Guadalupe Reservoir	●				●				○	○		●				●					
23	Lake Elsmar	●									○			●			●					
24	Campbell Percolation Ponds					●							●	●			●					
25	Lexington Reservoir	●								●	●		●	●			●					
26	Vasona Reservoir					●				●	●		●	●			●					
27	Cotton Wood Lake									●	●		●	●			●					
28	Los Gatos Creek	●				●	●				○			●			●			○	○	
29	Sandy Wool Lake										●		●	●			●					
30	Guadalupe River									○	●		●				●			○	○	
31	San Felipe Creek									○	○		○	○			●					
32	Coyote Reservoir	●	●							○	○		●	●			●					
33	Anderson Reservoir	●				●				●	●		●	●			●					
34	Cherry Flat Reservoir	●	●							○	○		●				●				●	
35	Coyote Creek									○	●		●	●			●	●		●	●	
36	Arroyo De La Laguna ¹									●	●		○	○			●			●	●	
37	Shadow Cliffs Reservoir										●		●	●			●			●	●	
38	Arroyo Del Valle ¹	●				●				○	○		●	●			●			○		
39	Del Valle Reservoir	●								●	●		●	●			●					
40	Alameda Creek		●			●				●	●		●	●			●			○	○	
41	Elizabeth Lake ¹										●		●	●			●					
42	Arroyo Hondo ¹	●					●			●	●		●	●			●				●	
43	Calaveras Reservoir	●									○		●	○			●					
44	San Antonio Reservoir	●									○		●	●			●					
45	Cull Canyon Reservoir									●	●		●	○			●					
46	San Lorenzo Creek ¹									●	●		●	●			●			●	●	
47	San Leandro Reservoir	●									○		●	●			●					
48	Lake Chabot	●									●		●	●			●					
49	San Leandro Creek						●			○	○		○	○			●			○	○	
50	Lake Temescal									●	●		●				●					
51	Lake Merritt									●			●	○			●					
52	Briones Reservoir	●									○		●	○			●					
53	San Pablo Reservoir	●									●		●	●			●					
54	Lafayette Reservoir	●									●		●	●			●					
55	Pinole Creek									○	○		●	●			●			●	●	
56	Walnut Creek ¹									○	○		●	●			●					
57	Mallard Reservoir ²	●	●	●	●						○		●				●					
58	Marsh Creek									○	○		●				●	●				
59	Marsh Creek Reservoir									○	○		●				●	●				
60	Contra Loma Reservoir ²	●	●	●	●						●		●	●			●					
61	Lake Curry	●									○		●				●					
62	Lake Madigan	●	●								●		●	●			●					

Table 6. Existing and potential Beneficial Uses of Surface Waters^a (continued)

	SURFACE WATERS	MUN	AGR	IND	PROC	GWR	FRSH	NAV	POW	REC 1	REC 2	COMM	WARM	COLD	BIOL	SAL	WILD	RARE	MAR	MIGR	SPWN	SHELL
63	Lake Frey	●									●		●				●					
64	Suisun Creek									○	○		●	●	○		●			●	●	
65	Suisun Slough									●	●		●		○		●					
66	Montezuma Slough									●	●		●		○		●	●				
67	Lake Herman	●									○		●	●			●					
68	Chiles Creek	●					●			○	○		●	●			●					
69	Sage Creek	●					●			○	○		●	●			●					
70	Lake Hennessey	●									●		●	●			●				●	
71	Conn Creek	●					●			●	●			●			●			●	●	
72	Rector Reservoir	●											●	●			●					
73	Milliken Reservoir	●									○		●				●					
74	Lake Marie	●	●							○	○		○				●					
75	Lake Chabot	●	●							●	●		●	●			●					
76	Dry Creek	●	●							●	●			●	○		●			●	●	
77	York Creek									○	○			●	●		●			●	●	
78	Napa River	●	●					●		●	●		●	●	○		●	●		●	●	
79	Sonoma Creek									●	●		●	●	○		●	●		●	●	
80	Petaluma River							●		●	●		●	●	○		●	●		●	●	
81	San Antonio Creek									○	○		●	●	○		●			○	○	
82	Stafford Lake	●									●		●	○			●					
83	Novato Creek	●								○	○		○	○			●			○	○	
84	Rodeo Lagoon									●	●		●	●			●					
85	Miller Creek									○	○		●	●			●	●		○	○	
86	Lake Lagunitas	●									●		●	●			●					
87	Bon Tempe Lake	●									●		●	●			●					
88	Alpine Lake	●									●		●	●			●					
89	Kent Lake	●									●		●	●			●					
90	Lagunitas Creek									●	●			●	○		●	●		●	●	
91	Phoenix Reservoir	●									○		●	●			●					
92	Nicasio Creek	●					●			●	●		●	●			●			●	●	
93	Nicasio Reservoir	●					●				○		●				●					
94	Olema Creek									●	●			●			●			●	●	
95	Walker Creek									○	○			●	○		●	●		●	●	
96	Crystal Lake									○	○		●				●					
97	Pacific Ocean			●				●		●	●	●				●	●	●	●	●	●	●
98	South Bay			●				●		●	●	●				●	●	●	●	●	○	●
99	Lower Bay			●				●		●	●	●			○		●	●	●	●	○	●
100	Central Bay			●	●			●		●	●	●			○		●	●	●	●	●	●
101	San Pablo Bay			●				●		●	●	●			○		●	●	●	●	●	●
102	Suisun Bay & Lower San Joaquin			●	●			●		●	●	●			○		●	●	●	●	●	
103	Delta			●	●			●		●	●	●	●		○		●	●		●	●	
104	Bolinas Lagoon									●	●	●				●	●	●	●	●	●	●
105	Drakes Estero									●	●	●				●	●	●	●		●	●
106	Limantour Estero									●	●	●				●	●	●	●		●	●
107	Tomaes Bay									●	●	●				●	●	●	●	●	●	●
108	San Pedro Creek										●		●	●			●			●	●	
109	Pomponio Creek									○	●			●			●			●	●	
110	Corte Madera Creek										●			●			●	●				
111	Mill Valley Creek										●			●			●					
112	Pine Gulch Creek	●									●			●			●			●	●	
113	Kimball Reservoir	●									○		●				●					

NOTES:

1. Includes Upstream Tributaries.
2. Offstream Reservoir
- Potential Beneficial Use.
- Existing Beneficial Use.



Beach along the Great Highway



Lafayette Reservoir

serve as a basis for establishing water quality objectives and discharge prohibitions to achieve this goal.

The list of beneficial uses in Table 6 is considered an accurate reflection of beneficial use demands on basin water resources. Anticipated future beneficial uses of waters in the Basin are also included, although they may vary for a given water body depending upon future population demands, land use and water resource developments.

Water Quality Objectives

The establishment of water quality objectives, as with other aspects of water quality control planning, has become more complex in recent years because of increasing levels of protection demanded; largely the result of increased public awareness of benefits associated with a clean and healthy environment. There is now a need for water quality protection for recreation, wild life habitat, fish migration, preservation of rare and endangered species, and other beneficial uses which have not always been considered in purely

utilitarian resource management. Further where water quality is high, there is a commitment to maintain high standards.

Water quality objectives for the Basin are designed to protect waters for the beneficial uses described earlier. Where existing water quality exceeds that quality necessary to protect the designated beneficial uses, existing quality guided the selection of values for constituent concentrations or properties. Such an approach is consistent with the State's "Nondegradation Policy" which states that "... whenever the existing quality of water is better than the quality established in policies as of the date on which such policies become effective, such existing high quality will be maintained until it has been demonstrated to the State that any change will be consistent with the maximum benefit to the people of the State, will not unreasonably affect present and anticipated beneficial use of such water and will not result in water quality less than that prescribed in the policies."

Water quality objectives recommended here for the protection of beneficial uses were developed

from data reviewed during this study and from the literature, including published and unpublished reports. Recommendations from the State and Regional Board staff, the University of California Board of Consultants, the Agricultural Extension Service, and the Departments of Water Resources, Health, and Fish and Game of the State of California were also considered. It should be emphasized that the word "objective" is used in this section rather than the word "criterion." In a water quality sense, an objective is defined as a formal standard toward which an effort of control is directed. A criterion on the other hand is more commonly employed when judging the suitability of a water resource for a particular beneficial use.

In general, the recommended objectives are intended to govern the concentration of pollutant constituents in the main water mass. Obviously, the same requirements cannot be applied at or immediately adjacent to submerged effluent discharge structures. Allowable zones of dilution within which higher concentrations will be tolerated should be defined for each discharge at the time discharge permits are drafted.

Surface Water Quality Objectives for Ocean Waters

Ocean waters of Bay Basin include the Pacific Ocean from Pescadero Point to the mouth of Tomales Bay and the waters adjacent to the Farallones Islands. The water quality objectives contained in the "Water Quality Control Plan for Ocean Waters of California; adopted July 6, 1972, and subsequent amendments pertaining to bacteriological characteristics, adopted as revisions in March 1973 shall apply to these waters. Specific objectives for temperature in ocean waters are as specified in the State Board's "Water Quality Control Plan for Control of Temperature in the Coastal and Interstate Waters and Enclosed Bays and Estuaries of California."

Surface Water Quality Objectives for Waters Inland from Golden Gate

The following water quality objectives are recommended for the protection of beneficial use and aesthetic enjoyment of all surface waters inland from the Golden Gate. Both State Board's "Thermal Plan" which sets forth objectives for temperature in surface waters of the State and "Water Quality Control Policy for Enclosed Bays

and Estuaries of California" are applicable to all surface waters inland from the Golden Gate in the Bay Basin.

pH. All waters shall be maintained within the pH range 6.5-8.5; within this pH range waste discharges shall not cause deviations of more than 0.2 units in estuarine waters or more than 0.5 units in fresh waters.

Dissolved Oxygen. All waters designated as aquatic life habitat shall be maintained at protection level B, unless otherwise designated.

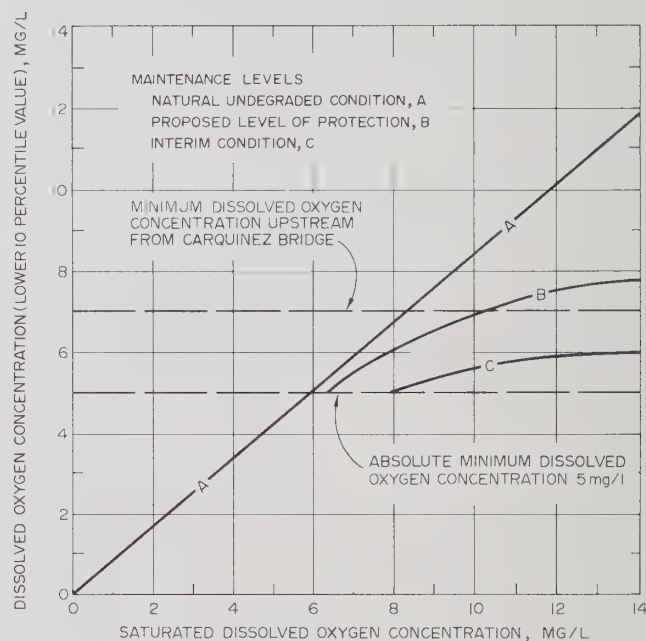


Figure 4. Lower 10 Percentile Dissolved Oxygen Concentration Value

For all tidal waters, the following objectives shall apply:

In the Bay downstream of the Carquinez Bridge 5.0 mg/l minimum

Upstream from Carquinez Bridge 7.0 mg/l minimum

For nontidal waters, the following objectives shall apply:

Waters designated as cold water habitat 7.0 mg/l minimum

Waters designated as warm water habitat 5.0 mg/l minimum

Areas of Special Biological Significance shall be maintained at a level of protection consistent with natural undegraded conditions uninfluenced by any controllable water quality factor.

Where natural factors cause lower concentrations, controllable water quality factors shall not cause further reduction.

In addition to these limiting numerical objectives, dissolved oxygen concentration, lower 10 percentile value, shall be determined as a function of dissolved oxygen content at saturation, in accordance with Figure 5.

Biostimulation. All waters shall be maintained such that the level of biotic growth does not cause nuisance or adverse effects on any protected beneficial water use as a result of man's activity. Whenever natural factors cause such biotic growths, then controllable factors shall not cause further increase.

Turbidity. All waters shall be free from unnatural changes in turbidity or light transmittance where

change impairs beneficial use. Deviations from normal background light penetration or turbidity relatable to waste discharge shall not be greater than 10 percent in areas of 10 JTU or more; waters of characteristically low natural turbidity shall be maintained so that discharges do not cause visible, aesthetically undesirable contrast with the natural appearance of the water.

Sulfide. All waters shall be free from dissolved sulfide concentrations above natural background levels.

Coliform Bacteria. Water quality objectives for bacterial indicators are listed below:

1. Waste discharges shall not cause tidal waters to exceed a most probable number (MPN) of coliform organisms of 1000 per 100 ml; provided that not more than 20 percent of the samples at any sampling station in any 30-day period may exceed 1000 per 100 ml, and provided further that no single sample shall exceed 10,000 per 100 ml; nor shall the discharge cause the receiving water to exceed a



Quarantine Restrictions Posted near Richardson Bay

fecal coliform median value of 50 MPN per 100 ml.

2. Waste discharges into waters capable of supporting unrestricted shellfish harvesting shall not cause those waters to exceed a median coliform concentration of 70 MPN per 100 ml, nor shall more than 20 percent of the samples exceed 230 MPN per 100 ml. Unrestricted shellfish harvesting areas shall, in every other respect, comply with the requirements of the "National Shellfish Sanitation Program."
3. Waste discharges into nontidal waters shall not cause the level of coliform organisms to exceed the limits established below:
 - a. For nontidal receiving waters used for drinking water supply, the arithmetic average of at least five (5) samples collected over a thirty (30) day interval shall not exceed a total coliform MPN of 100 per 100 ml or a fecal coliform MPN of 20 per 100 ml.
 - b. For nontidal receiving waters used for water contact recreation (REC-1), the log mean of fecal coliform MPN values shall not exceed 200 MPN per 100 ml; nor shall more than 10 percent of the samples taken exceed a fecal coliform MPN of 400 per 100 ml.

Detrimental Deposits. All waters shall be free of substances attributable to controllable water quality factors that will form detrimental deposits and free from presence of material that can cause or induce formation of combinations or amounts of deposited materials that can be deleterious to beneficial uses of waters and underlying surfaces, with or without resuspension of any deposits.

Floatables. Surface waters shall be free of visible oil, scum, floating debris or other floating substances attributable to controllable water quality factors that produce adverse effects on beneficial uses.

Color, Odor and Taste. All waters shall be free of substances attributable to water quality factors that produce detrimental, esthetically undesirable color, odor or taste.

Fish Flesh Tainting. All waters shall be free of substance attributable to controllable water qual-

ity factors in concentrations sufficient to impart unnatural odor or taste to fish flesh or other edible products of aquatic origin.

Radioactivity. Radionuclides attributable to controllable water quality factors shall not be present in the waters in concentrations in excess of those given in California Administrative Code, Title 17, or in concentrations which will result in accumulations of radionuclides in aquatic life to an extent which presents a hazard either to aquatic life or their consumers.

Toxicity. No substances attributable to controllable water quality factors shall be present in waters in concentrations or combinations which are toxic to, or which produce detrimental physiological responses in humans, plants, fish and other animal life, or which create undesirable tastes or odors in organisms utilized for human consumption.

Pesticides. Surface waters shall not contain concentrations of total identifiable chlorinated hydrocarbon pesticides at detectable levels as determined by use of analytical methods prescribed in "Standard Methods for the Examination of Water and Wastewater," latest edition.

Ammonia. The discharge of wastes shall not cause concentrations of un-ionized ammonium hydroxide (NH_4OH) to exceed 0.025 mg/l measured as nitrogen in receiving waters.

Chemical Quality. No substances attributable to controllable water quality factors shall impair the treatability (require treatment beyond presently accepted practices) of receiving waters used for municipal and domestic supply or waters which are used for irrigation and livestock watering. In waters used for municipal or domestic supply concentrations of chemical constituents shall not exceed mandatory limits as established by the California State Department of Health.

A mean daily chloride concentration of 4,000 mg/l or less shall be maintained in waters east of the westerly end of Chipps Island.

A mean monthly salinity at high tide of 18,000 mg/l TDS or less shall be maintained in the waters surrounding and adjacent to Suisun Marsh.

The quantity and quality of water in the bays and intertidal sloughs of Suisun Marsh shall be sufficient to produce an average salinity of 900 mg/l

TDS in the first 12 inches of soil between April 15 and June 1 of each year.

The following chemical quality limits shall be maintained in the surface waters of the Alameda Creek watershed above Niles:

TDS: 250 mg/1 90 day—arithmetic mean
360 mg/1 90 day—90th percentile
500 mg/1 daily maximum

Chlorides: 60 mg/1 90 day—arithmetic mean
100 mg/1 90 day—90th percentile
250 mg/1 daily maximum

Groundwater Quality Objectives

No controllable water quality factor shall degrade the quality of any usable groundwater resources or adversely affect long-term soil productivity. Where wastewater effluents are returned to land for irrigation uses regulatory controls shall be consistent with Title 17 of the State Health Code and with relevant controls for local irrigation sources.

Nondegradation Objective

The policy enumerated in the State Water Resources Control Board Resolution 68-16, "Statement of Policy With Respect to Maintaining High Quality Waters in California" shall apply to all waters of the State within the Basin.

Effluent Limits

Federal guidelines on secondary treatment, best practicable treatment effluent limits and the national policy that discharge of pollutants in toxic amounts shall be prohibited are of direct concern to basin planning. Proposed effluent limits for discharges from publicly-owned treatment works, published by EPA in the Federal Register (40 CFR-133) on August 7, 1973, effectively define secondary treatment. These limits, which are required by 1977, are:

1. Biochemical oxygen demand (5-day) shall not exceed 30 mg/1 as a monthly average and 45 mg/1 as a weekly average.
2. Suspended solids shall not exceed 30 mg/1 as a monthly average and 45 mg/1 as a weekly average.

3. Fecal coliform bacteria density shall not exceed 200 MPN/100 ml as a monthly geometric mean and 400 MPN/100 ml as a weekly geometric mean.

4. pH shall be within the range of 6.0-9.0.

These limits may be modified where difficult industrial wastes are present which warrant revision of effluent values, particularly BOD and suspended solids; nonetheless, 85 percent removal of these two parameters will be required.

Recent federal policy regarding Best Practicable Treatment technology (BPT) for municipal wastewater facilities was expressed in a preliminary report published by EPA on March 25, 1974. The preliminary report on BPT for sewage does not establish specific standards but merely emphasizes that municipalities requesting federal funds must assess all possible alternatives and select the most cost-effective method for its needs.

In addition to effluent limitations established by the Environmental Protection Agency for secondary treatment, specific limitations for the disposal of treated point source wastes are included as part of the Basin Plan. These additional effluent limitations pertain to toxicity in both deep and shallow water discharges, coliform bacteria, residual chlorine, restriction regarding the uses for reclaimed wastewaters and other limits which may be included as part of waste discharge permits required under the National Pollutant Discharge Elimination System.

Toxicity

Toxicity controls on effluents will be forthcoming from the EPA pursuant to Section 307 of the Federal Water Pollution Control Act as amended in 1972. EPA has presently under consideration a list of toxicants which include mercury, cadmium, cyanide, polychlorinated biphenyl and a list of pesticides, including DDT, DDE, DDD, and toxaphene. Most of these materials are cumulative poisons which can biomagnify in the food chain. Although specific effluent limits have not been established, it is expected that limits will be adopted upon completion of public hearings being conducted on this subject later this year.

Deepwater Discharges. No effluent shall exhibit a TLM of less than 100 percent under a 96-hour bioassay with acceptable test organisms.

If the discharger can demonstrate to the satisfaction of the Regional Board, pursuant to public hearing, that the principal toxicant in the effluent is a nonconservative toxicant which is subject to rapid decay in the receiving water and that the wastewater is rapidly rendered harmless upon discharge, then the Regional Board will establish revised toxicity requirements.

Shallow Water Discharges. The survival of test fishes in 96-hour bioassays of the effluent shall achieve a median of 90 percent survival and a 90 percentile value of not less than 70 percent survival.

Coliform Bacteria

No waste discharge wherein effluent volumes comprise 10 percent or more of the receiving water volume (exclusive of previously discharged effluent) at point of access shall exceed a most probable number of coliform organisms of 2.2 per 100 ml.

Residual Chlorine

Wastewaters shall not contain residual chlorine upon discharge; it is recommended that control of chlorine removal be based on maintenance of minimal SO₂ residual or equivalent techniques to avoid overdosing of chemicals used in chlorine removal.

Wastewater Reuse

Reclamation of wastewater for reuse must include treatment sufficient to achieve those quality limits prescribed in Title 17, Chapter 5, Subchapter 1, Group 12, California Administrative Code for the use intended. This section of the Administrative Code, recently revised by the State Department of Health, is a formal expression of the Department's position regarding reclaimed water uses involving ingestion. It is believed that stable organics may constitute a serious health problem where reclaimed wastewaters are used to augment domestic water supplies, and consequently projects contemplating such use will not be approved by the Department of Health until the effects of stable organics on the beneficial use are documented.

Other uses for reclaimed wastewaters are not faced with such severe restrictions. Either sewerage agencies or local water or irrigation districts could provide the increment of treatment neces-

sary under Title 17 to allow unrestricted use of effluents on land without unusual controls on irrigation practices or crop selection. In some areas the increment of treatment may be more economic than water importation or continued reliance on poorer quality groundwaters. Under such an arrangement an effluent requirement would be that biological oxidation and filtration were provided and that a coliform limit of 2.2 MPN/100 ml were met somewhere within the treatment process. Other less stringent requirements are provided in Title 17 for fodder, fiber, and seed crop use, wherein filtration would be waived but disinfection would be more stringent than the federal effluent requirement.

Waste Discharge Permits

The State of California program for issuing waste discharge permit under the National Pollutant Discharge Elimination System has been approved by the Environmental Protection Agency giving California responsibility for establishing effluent limitations for all permit applicants. Effluent limitations established by the State are reviewed by EPA which retains veto authority over the State permit program.

In addition to effluent limits established for municipal treatment facilities, EPA has promulgated specific effluent limitations for existing industrial waste discharges together with standards of performance and pretreatment standards for new sources pursuant to Sections 304(b), 306(b) and 307(b) of the Federal Water Pollution Control Act.

In most cases the effluent limits contained in the industrial standards are performance standards based on normal practice in each industrial category. Nevertheless, best practicable treatment guidelines may require significant changes in effluent disposal practices for many existing industrial establishments.

Problem Assessment

An assessment of existing and anticipated water quality problems involves identifying and quantifying point and diffuse (nonpoint) waste loads, evaluating by mathematical modeling techniques, the relative effect of future waste loads on the aquatic environment, and classifying basin receiving water segments in regard to pollution problems.

Table 7. Untreated Waste Loads^a

Planning unit	ADWF			BOD ₅			TN			TP			N-NH ₃		
	1970	1985	2000	1970	1985	2000	1970	1985	2000	1970	1985	2000	1970	1985	2000
Marin-Sonoma															
Municipal	18.6	29.9	42.8	43.46	68.53	97.51	10.07	17.47	27.14	1.99	3.06	4.66	6.03	10.47	16.29
Industrial	.7	1.2	1.9	3.67	4.55	5.61	.22	.34	.59	-	-	-	.04	.07	.14
Napa-Solano															
Municipal	17.8	29.6	50.8	40.12	70.65	123.82	6.74	11.99	21.33	1.78	3.01	5.55	4.03	7.19	12.79
Industrial	4.8	7.9	8.3	27.13	32.40	36.18	5.82	6.98	7.84	-	-	-	3.73	4.17	4.65
Contra Costa															
Municipal	42.7	58.9	74.3	81.02	116.21	150.87	16.12	22.64	28.93	4.33	6.27	7.75	9.66	13.59	17.36
Industrial	304.9	281.2	259.9	354.55	488.09	704.01	75.66	74.52	54.56	-	-	-	69.19	59.42	33.72
East Bay															
Municipal	107.3	120.6	137.5	201.59	229.37	257.15	35.91	41.63	47.54	9.57	11.49	12.82	21.56	24.98	28.53
Industrial	13.0	17.8	21.6	67.05	103.42	134.24	5.97	6.77	6.42	-	-	-	.23	.32	.42
Livermore Valley															
Municipal	7.4	15.7	24.3	15.41	32.06	42.79	2.61	5.38	7.95	.69	1.48	2.18	1.57	3.23	4.78
Industrial	.2	.2	.2	.88	1.66	2.63	.04	.08	.12	-	-	-	-	-	-
South Bay															
Municipal	104.1	140.5	176.4	232.01	334.83	426.87	45.23	66.67	83.81	37.66	56.82	75	27.16	40	50.29
Industrial	9.1	11.7	13.7	41.92	45.81	54.80	2.25	3.29	5.27	-	-	-	.60	.91	1.94
San Mateo															
Municipal	46.2	54.4	61.1	95.32	112.23	126.99	17.69	21.32	24.44	4.82	5.79	6.65	10.61	12.79	14.64
Industrial	22.7	16.7	16.0	38.82	45.17	52.99	6.26	10.07	15.48	-	-	-	.54	.93	1.55
San Francisco															
Municipal	91.2	96.2	107.3	193.42	167.17	170.04	28.55	29.18	29.89	8.33	8.49	8.65	17.13	17.50	17.93
Industrial	10.4	10.6	10.8	30.88	30.46	30.78	.96	1.24	1.60	-	-	-	.26	.25	.26
Basin total															
Municipal	435.3	545.8	674.5	902.35	1,131.05	1,400.54	162.92	216.28	271.03	69.17	96.41	123.26	97.75	129.75	162.61
Industrial	365.8	347.3	332.4	565.5	751.56	1,021.24	97.18	103.29	91.88	-	-	-	74.59	66.07	42.68

ADWF - Average dry weather flow, million gallons per day.

BOD₅ - 5-day biochemical oxygen demand, thousand pounds per day.

TN - Total nitrogen, thousand pounds per day.

TP - Total phosphorus, thousand pounds per day.

N-NH₃ - Ammonia, thousand pounds per day, as nitrogen.

Waste Load Projections

Analysis of present volumetric and quality characteristics of wastewaters generated in the Basin provides a rational basis for projecting future flows and loadings. For comparative purposes, waste loads were separated into two categories—those generated by point sources and those remaining which have been classed as nonpoint sources. Municipal and industrial waste flows comprise point source waste loads while urban and nonurban runoff, agricultural operations, aerial fallout and other identifiable diffuse sources comprise the nonpoint or unregulated waste loads.

From the standpoint of water quality control municipal wastewater has received the most atten-

tion. Municipal wastewaters consist primarily of domestic sewage but in some systems the portion of flow from nondiscrete heavy industrial establishments may reach as high as 20 percent of total inflow to the plant. Significant waste flows and loads are generated by heavy industries which discharge directly to the receiving waters of the Bay or to municipal collection systems. Six standard heavy industrial classifications considered in this report included: food and kindred products, pulp and paper products, petroleum refinery, organic and inorganic chemical manufacture, primary metals and fabricated metals.

Projected waste flows and untreated loads are summarized in Table 7. Two sets of projections are shown; one representing the municipal portion of flows and loads exclusive of heavy indus-



Stormwater Runoff near Palo Alto

try, and the second accounting for all heavy industry, including both discrete and municipally-tied dischargers. By year 2000 the combined municipal and heavy industrial average dry weather flow is expected to increase 27 percent over present waste flows.

A principal endeavor of wastewater management planning is to evaluate alternative approaches by which the discharge of wastes to receiving waters from man's activities can be reduced. As revealed by this study, these approaches must consider both point and nonpoint sources to provide effective solutions to water quality problems.

Near the end of the planning period, the relative contribution of BOD₅ from nonpoint sources may amount to as much as 40 percent of the total load on receiving waters. This relationship between point and nonpoint sources of this constituent is shown in Figure 5, assuming secondary treatment for all publicly operated treatment plants and effluent limitations as promulgated by EPA for heavy industrial waste sources.

Waste loads from nonpoint sources occur primarily from urban and nonurban runoff over a six

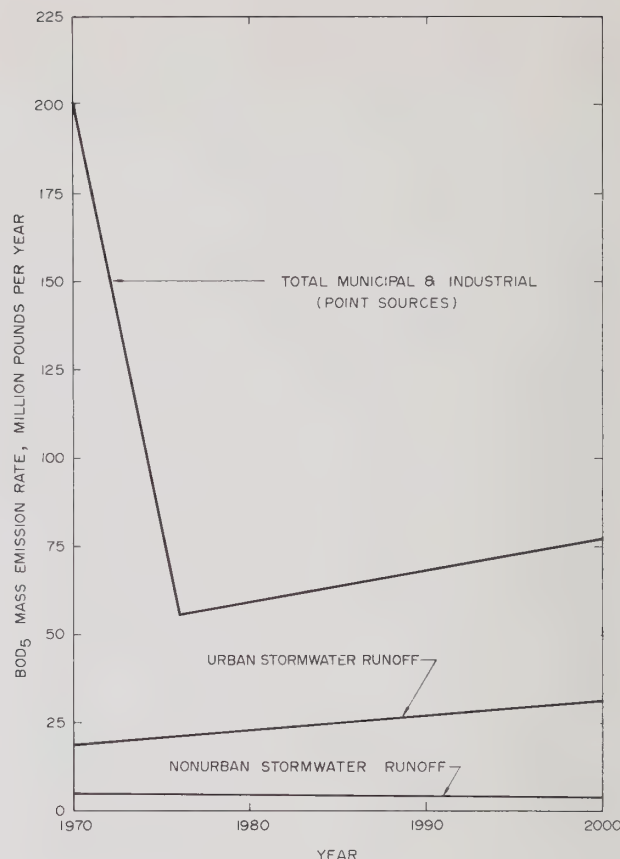


Figure 5. Projected BOD₅ Mass Emissions

month period from November through April causing measurable impact on receiving water quality. If additional control measures for waste sources are found necessary to achieve water quality objectives, control of pollutants from urban runoff will need to be considered.

Nonpoint source waste loads, unlike point source wastes, cannot be readily quantified through flow measurement and sampling and analysis techniques. It is necessary, therefore, to calculate such waste loads from land use data, quantities of applied irrigation water, surface runoff, etc.

The major portion of nonpoint source waste loads is that from stormwater runoff. Waste loadings from other diffuse sources represent only a small portion of the total load and are difficult to analyze and control. Projected total waste loads attributable to nonpoint sources are presented in Table 8.

Water Quality Evaluation

Anticipated water quality conditions for Bay water segments under future wasteloads are gen-

erally found, by mathematical modeling, to be good with several exceptions in the extremities of the Bay system; principally in the shallow South Bay waters, the Napa and Petaluma estuaries, and the marshes and sloughs of the Suisun area. In these segments, low dissolved oxygen concentrations are anticipated to occur without additional treatment beyond secondary levels. In addition, higher toxicity levels and nutrient concentrations are projected due to the limited tidal exchange and dilution capability.

In the South Bay, the segment of greatest concern, adverse water quality conditions derive from high mass emission of wastewater in low dispersion areas, resulting in depressed dissolved oxygen levels, and high nutrient and toxicity concentrations. Water quality objectives, and nutrient

and toxicity criteria are expected to be met only if additional treatment operations removing greater amounts of oxygen demanding substances are employed in conjunction with an improved discharge location allowing greater dispersion.

In Petaluma and Napa Rivers, the Sonoma Creek and Suisun Marsh area low dissolved oxygen levels are anticipated to continue to occur if current municipal and agricultural oxygen demand and nutrient loads are not reduced or eliminated. Although adverse algal activity is presently limited by several factors in these areas, additional nutrient loads in the future in combination with potentially increasing euphotic depths are projected to result in greater algal productivity unless waste emissions are reduced.

Table 8. Nonpoint Source Emissions^a

Land use	County	Waste load parameter ^a							
		BOD ₅		SS		N		P	
		1970	2000	1970	2000	1970	2000	1970	2000
Urban	San Francisco	1,400	1,400	11,000	11,000	220	220	39	39
Nonurban		32	28	9,900	8,400	27	22	2	2
Urban	Marin	1,600	3,200	12,000	26,200	250	510	45	94
Nonurban		970	850	293,800	258,000	780	700	60	51
Urban	San Mateo	3,100	3,300	17,280	25,700	490	510	61	91
Nonurban		600	540	183,400	160,000	483	430	36	32
Urban	Sonoma	290	1,000	2,300	8,100	45	160	8	28
Nonurban		420	260	130,000	78,000	340	210	26	16
Urban	Napa	450	1,300	3,500	11,000	71	210	13	37
Nonurban		584	534	169,000	159,000	460	420	34	32
Urban	Solano	690	1,400	5,500	11,000	110	225	20	40
Nonurban		370	340	111,000	101,000	300	270	22	20
Urban	Contra Costa	3,900	6,400	32,600	51,400	640	1,000	110	180
Nonurban		620	460	181,100	135,800	490	370	36	28
Urban	Santa Clara	4,800	7,300	29,600	58,000	790	1,200	140	200
Nonurban		1,000	870	300,000	260,000	820	700	60	52
Urban	Alameda	3,200	5,060	25,301	41,000	500	780	92	145
Nonurban		500	420	149,100	88,000	404	327	30	25
Urban	County subtotals	18,170	30,360	149,060	243,400	3,116	4,815	528	854
Nonurban		5,096	4,302	1,527,300	1,248,500	4,104	3,449	306	258
Aerial fallout on San Francisco Bay		-	-	-	-	2,168	2,168	274	274
Total nonpoint mas emissions		23,266	34,662	1,676,360	1,491,900	9,388	10,432	1,108	1,386

^a All mass emissions expressed in thousand pounds per year of biochemical oxygen demand (BOD₅), suspended solids (SS), nitrogen (N), and phosphorus (P).

Modeling results indicate that toxicity concentrations through the open waters of both the northern and southern portions of the Bay will not exceed criteria with the use of dechlorination at all municipal treatment facilities and ammonia reduction employed at the Napa, Petaluma, Fairfield and South Bay Dischargers systems.

Algal productivity throughout the Suisun Bay and San Pablo Bay area is found to be most directly limited by the depth of light penetration. Nitrogen concentrations are presently at levels which would cause much greater algal productivity if suspended solids levels were lowered. As increased clarity is anticipated to cause increased algal activity, Delta operations in the form of reduced flows, transporting less sediments into the region, may have potentially adverse effect on the system when considered in conjunction with increased nutrient loads from both municipal and agricultural sources contributing to the western Delta area.

Modeling work indicates that, under nutrient loads imposed on the Bay system from municipal, industrial, and agricultural discharges (including the proposed San Joaquin Agricultural Drain discharge at Antioch), total nitrogen concentrations in the receiving water will approach criterion levels. The possibility of increased algal blooms during portions of the year under critical loading conditions necessitates further study, during the next decade of project planning, of the cause and effect of such blooms, the merits of nutrient reduction by control or treatment, and the costs associated with such measures.

Classification of Waters

It is necessary, in conformance with the planning requirements of EPA, to classify and rank basin waters according to severity of pollution in order that the most adverse problems may receive priority solution by effective funding. This procedure entails delineating water segments, classifying

Table 9. Water Segment Classification^a

Receiving water segment	Description	Classification	Category ^a
1	Pacific Ocean	Effluent limited	Z
2	Central San Francisco Bay	Effluent limited	Z
3	San Pablo Bay	Effluent limited	Y
4	Suisun Bay	Effluent limited	Y
5	Lower San Francisco Bay	Effluent limited	Y
6	South Bay	Water quality limited	X
7	Suisun Marsh	Water quality limited	Y
8	Napa River	Water quality limited	X
9	Petaluma River	Water quality limited	X
10	Sonoma Creek	Water quality limited	Y
11	Alameda Creek	Water quality limited	Y
12	Richardson Bay	Water quality limited	X
13	Tomales Bay	Water quality limited	X
	Other surface water segments ^b	Effluent limited	Z

^a Categorization basis:

X - Present pollution problems anticipated to continue with conformance to 1977 federal limitations only.

Y - Future pollution problems may occur with 1977 federal limitations only.

Z - No pollution problems anticipated with conformance to 1977 federal limitations.

^b Includes Coyote, Guadalupe, Walnut, Nicasio, and Pescadero creeks, as well as all fresh water impoundments.

Table 10. Assimilative Capacities of Water Quality Segments^a

Water segment	Description	Parameter	Assimilative capacity, ppd
6	South Bay	UOD	140,000
7	Suisun Marsh	UOD, TN	a
8	Napa River	UOD	8,000
9	Petaluma River	UOD	6,000
10	Sonoma Creek	UOD	a
11	Alameda Creek	TDS	b
12	Richardson Bay	Coliform	b
13	Tomaes Bay	Coliform	b

^a Insufficient information presently available to determine segment assimilative capacity.

^b The concept of assimilative capacity is not germane to pollution problems associated with the parameters of concern.

them through a process involving assimilative capacity determination and ranking them in order of the severity of pollution problems associated with each.

A water segment is defined as a portion of the Basin where surface waters have common hydrologic characteristics, common physical, chemical and biological aspects and, thusly, similar reactions to pollutants. Thirteen receiving water segments of the Basin have been identified as listed in Table 9. These segments are classified according to whether or not water quality objectives were anticipated to be met after application of 1977 effluent limitations established by the federal government. "Effluent limited" segments are anticipated to meet criteria, whereas "water quality limited" segments would not. Eight segments are designated as water quality limited.

Assimilative capacity is an expression of the capacity of a water segment to accept waste loads which will not interfere with attainment of receiving water quality objectives. In order to determine the need for, and extent of removal of specific constituents, an estimate of the total assimilative capacity of water quality limited segments needs to be determined. The eight water quality limited segments vary greatly in terms of physical nature and assimilative capacity. Some can be expected to assimilate a limited amount of waste load with no noticeable adverse effect while others will tolerate little or no mass emission of

waste materials during critical times of the year. As described in Table 10, assimilative capacity has been determined where possible by mathematical modeling procedures.

The relative severity of existing or future pollution problems can be considered from a multitude of standpoints including; the estimated economic loss of a resource, the magnitude of the correction measures, social impact of the adversity or the mitigation measure, the environmental consequences of "no action" and the threat to either public health or well-being.

The water segment ranking order described in Table 11 is based, to an appreciable extent, on the subjective judgments of the basin planner. The segments listed at the top of the ranking order should receive priority in the allocation of financial resources for water quality control. Such ranking is preliminary and as revisions in criteria and greater sophistication in classification is developed, modification in the order will probably occur.

There are few groundwater systems in the Bay Basin that are adversely affected by waste discharges or are anticipated to be degraded by waste disposal operations in the future. Two groundwater systems, both in the Alameda Creek watershed, which are of concern with regard to potential water quality impairment are the Niles Cone in Southern Alameda County, which serves

Table 11. Segment Ranking Order^a

1.	South Bay
2.	Suisun Marsh
3.	Napa River
4.	Petaluma River
5.	Tomaes Bay
6.	Richardson Bay
7.	Alameda Creek
8.	Sonoma Creek
9.	Suisun Bay
10.	San Pablo Bay
11.	Lower San Francisco Bay
12.	Central San Francisco Bay
13.	Pacific Ocean

as a water supply for municipal and commercial needs of the Fremont-Union Area, and the upstream groundwater basins in the Livermore-

Amador Valley which serve both municipal and agricultural needs. Both groundwater systems are affected by the surface water quality of the Alameda Creek system which is considered a potential water quality problem area, thus a water quality limited segment, due to waste loads imposed during the dry months of the year. In addition, Niles Cone basin has been affected by salt water intrusion from Bay waters caused by severe overdraft.

Alternative Plans

The general approach taken in planning a comprehensive water quality management program for the Bay Basin differs somewhat from a more conventional evaluation of alternative facility plans that results in a selection of the "best" or "most effective" plan. The large number of feasible alternative plan possibilities which exist in the Basin, many of which have been reviewed and evaluated through subregional study efforts, necessitate a broad approach to the planning process.

Table 12. Cost Comparison for Various Planning Concepts^a

Concept	Capital cost, million dollars	Average annual cost, million dollars	Unit cost, dollars per million gallons	Cost comparison factor
A Existing programs	-	-	200	0.8
B Subregional plans	1,000	75	250-310	1.0
C Tertiary treatment	1,500	150	450-550	2.0
D Reclamation	-	180	600-750	2.5
E Land application	3,600	300	900-1,250	4.0

Notes:

- A - Estimated average of present treatment operations in Bay Area.
- B - Based on composited subregional estimates and O.T.C. cost data, all alternative Basin strategies represent the same approximate economic profile.
- C - Based on sedimentation, oxidation through nitrification, nutrient removal, filtration and carbon absorption at eight to ten regional plants within the Basin.
- D - Estimates are based on information in the draft report of the Interagency Reclamation Study.
- E - Land application schemes were conceptualized by the Corps of Engineers. Total annual costs of programs to serve a 12-county region were estimated to be in the vicinity of 400 million dollars per year with incremental capital costs (over base conditions) of 4 billion dollars. The Bay Area (Basin 2) represents about 75 percent of these costs.

All costs are approximate and based on 1973 dollar value (ENR Index = 2000).

The approach used involved (a) the survey of a number of "planning concepts," (b) consideration of basin-wide environmental issues, and (c) the development and analysis of selected "planning strategies." Screening of various planning concepts provides valuable insight into the relative merits of a wide range of water quality management approaches. Analysis of planning strategies establishes substantive bases for evaluating existing subregional study recommendations in light of new planning projections, revised water quality objectives, and uniform environmental considerations.

Screening of Planning Concepts

The water quality management concepts considered at the screening level were purposely chosen to cover a wide range of costs, performance, and reclamation potential. These approaches do not constitute discrete physical plans; indeed, features of each of the identified concepts can be expected to find application in any future wastewater management program serving the Bay region.

The concepts of major reuse of Bay Area wastewaters by reclamation for agricultural and landscape irrigation, flow augmentation, industrial needs, and possible unrestricted reuse for domestic supply in the future are now being considered more seriously and with greater care. These features are included in the selected planning concepts. Other approaches such as land application for wastewater treatment and basin-wide reuse by more costly processes of advanced treatment, have also been considered for the Bay Area.

Costs for various planning concepts envisioned for future wastewater management in the Basin are presented in Table 12. Planning concept A is basically a continuation of operation of existing wastewater treatment and disposal operations. This "no action" approach is shown for comparative purposes only, as existing wastewater disposal programs do not meet all planning objectives; clearly, any acceptable future program will be more costly. Planning concept B involves continued discharge of most wastewater to Bay Area receiving waters but with upgraded waste treatment and strategic consolidations modeled after the subregional study recommendations. Concept C responds to the pressure for consideration of advanced treatment for all discharges. It assumes a level of treatment including nutrient removal and carbon adsorption at eight to ten Bay Area

regional facilities. Planning concept D is that which maximizes reuse of renovated wastewater to serve large markets other than urban reuse. Use of major land application sites for wastewater treatment and recovery is the major feature of planning concept E, involving transport of secondary effluent to major land areas for application and collection before release to inland waterways, estuarine flow augmentation, or other beneficial reuse. Approaches C, D and E emphasizing large scale reclamation represent basin planning programs known to be more costly than discharge to the aquatic environment. Under current economic conditions they are found to be two to four times as expensive as concept B.

Screening of basin planning concepts does not lead to endorsement or rejection of the features emphasized by particular approaches, but does provide direction in the formulation of strategies for further analysis. For example, provision of advanced waste treatment cannot be justified as cost-effective except where required to meet water quality objectives and where shown to be a desirable alternative to other approaches. Similarly, large-scale reclamation projects can be expected to be implemented only where established markets and benefits are clearly identified. Land application of treated wastewater is becoming more widely utilized, particularly in small urban areas and areas not readily accessible to major receiving water bodies. However, large-scale land application projects such as those envisioned in planning concept E do not offer environmental advantages or other merits which outweigh their high cost.

Environmental Issues

Selection and analysis of viable alternatives is based, to a large extent, on basin-wide environmental issues. Key issues in the Basin have been identified as: (1) the use of advanced treatment versus the use of superior dilution-assimilation to achieve water quality objectives, (2) consolidation versus local treatment systems, (3) reclamation and reuse of the water resource and (4) flexibility to meet changing patterns of population growth.

Treatment Versus Dilution. Two practical means are available for achieving water quality objectives in Basin receiving waters; (1) provide advanced treatment, in which case effluent can be discharged to a higher "risk zone," and (2) discharge to a lower "risk zone" possessing superior assimilation capacity.

ative capacity characteristics in which case less treatment is required.

The two alternative solutions offer their own unique environmental advantages. Selection of an advanced level of treatment prevents a higher proportion of waste constituents from entering the aquatic environs and consequently, more closely approaches the "no discharge" solution. As a result, aquatic species experience the lowest risk of exposure to adverse concentrations of potentially harmful waste constituents. In the future, reclaimed wastewaters may prove suitable for fish and wildlife enhancement purposes.

On the other hand, discharge to areas with a high dilution-assimilation capability provides a safer point of disposal for waste flows under all circumstances.

Some environmental disadvantages are apparent in either of these solutions. Wastewater discharges, no matter how highly treated, are a cause for concern when constituents resist natural decay or tend to concentrate in biota or in substrates. Some difficult to remove pollutants are known to cause chronic biological ill effects if tolerance levels are exceeded. Even with the highest treatment levels practicable, problems may occur as a result of "abnormal discharges" which have the potential to disrupt the ecological balance. Disposal in portions of the Bay which are noted as lower risk zones that provide adequate dilution, dispersion and assimilation as indicated by modeling studies, reduces the possibility of significant adverse impact from both acute and chronic pollutants. Mechanisms of biomagnification by absorption or storage further reduce assurance that proposed water quality objectives alone are adequate to deal with potentially adverse chronic effects of certain waste constituents.

Considering the present lack of knowledge on waste constituents which may not be adequately removed by advanced treatment processes, may have long-term adverse effects, or may be deposited in the substrate and recycled at some future time; it is considered more sound environmental discretion to discharge away from the most environmentally sensitive areas during the foreseeable future. By doing so, the risk of causing unforeseeable adverse biological impacts is reduced.

Regional Versus Local. Large, regionalized treatment plants can have a major impact on sur-

rounding environments. Significant acreages of land must be acquired, including buffer zones. The size of such facilities would tend to make them highly visible. Surrounding areas may be adversely influenced by the presence of such plants, e.g., increased traffic, atmosphere emissions, and the social stigma associated with the presence of wastewater treatment facilities. Secondary effects such as depressed property values, nuisance odors, traffic congestion or land use modifications are possible.

In contrast, small plants serving local communities may use sites already committed to use for wastewater treatment and can be less obtrusive. Both primary and secondary impacts on the immediate surrounding area are likely to be of lower significance due to the reduced size of the facility and its operation. However, the collective basinwide impact of many small treatment plants may be of similar magnitude to that of a few large regional plants.

Adverse impacts may be reduced through careful plant site selection. At the basin planning level it is assumed that equitable and environmentally suitable sites will be selected.

A major feature which differs between regionalized and local systems is the network of interceptors. Regional systems normally consolidate collection districts by construction of major interceptors. Such conveyance systems require acquisition of major right-of-way easements. The potential for adverse impacts on remaining open space due to construction is much higher than is the case with existing local systems. Such adverse impacts, however, can be minimized by restricting the size and type of interceptor and its placement in existing corridors or previously disturbed areas.

An additional factor to be dealt with in consideration of relative environmental merits is the possible "growth inducement" role of the Basin Plan. Growth projections indicate that, in many portions of the Basin, future population will not be much greater than present levels. In these areas it is appropriate to address the "growth accommodating" impacts of the plan rather than its growth inducement role. The mere presence of wastewater collection and treatment facilities will not "induce" growth unless other limiting factors such as employment opportunity and availability of transportation are affected. In other areas where significant growth is anticipated, the size and placement of interceptors can influence future land use and development patterns.

Reclamation and Reuse. The capability of waste disposal programs to adapt for wastewater reclamation projects is another important environmental issue.

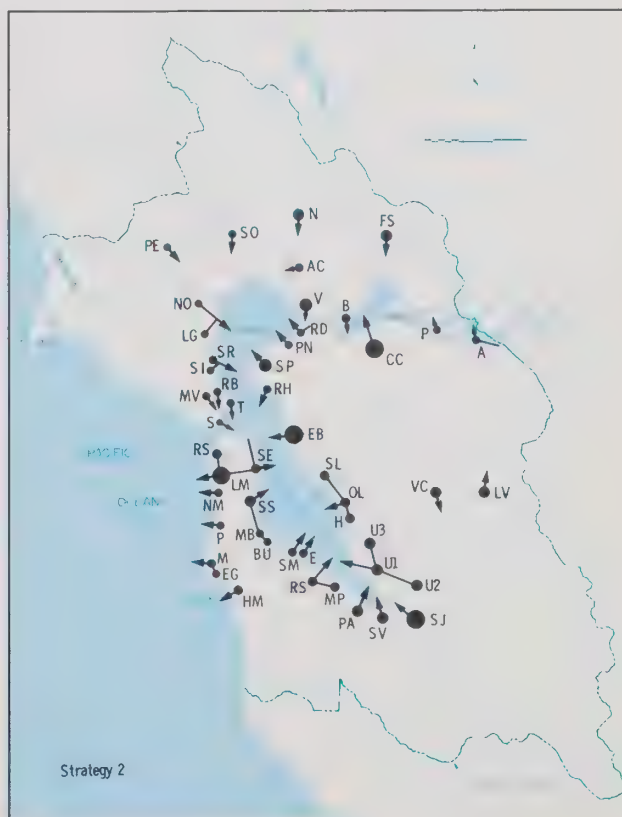
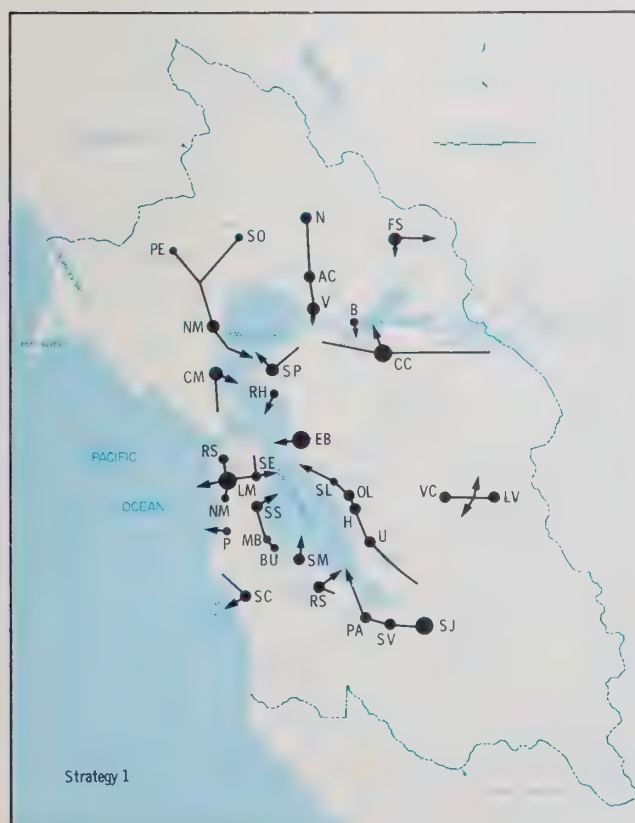
The most promising markets for reclaimed wastewaters in the immediate future appear to be agricultural uses, industrial uses, and some landscape irrigation. Other uses such as recreational lakes, limited groundwater recharge and stream-flow augmentation may be considered in certain cases. Such uses generally constitute environmentally desirable goals and are, in addition, mandated as such by the Porter-Cologne Act. Alternatives which retain and treat wastewaters in circumstances amenable to potential reuse markets are therefore considered environmentally superior.

Prior to the implementation of a wastewater reclamation program fail-safe measures for effluent disposal to an acceptable location must be provided. In addition, once wastewater reclamation is practiced, a safe point of disposal must still be provided for "abnormal" discharges, peak wet weather flows and other quantities in excess

of reclamation needs. Thus, alternatives which provide maximum flexibility for future reclamation must also provide adequate safety measures for disposal of such wastewaters.

Flexibility. The issue of flexibility to meet changing patterns of population growth incorporates aspects of the previously discussed topics. Waste discharge requirements are based on consideration of water quality objectives and projected waste loads. If actual growth significantly exceeds projected growth, then the condition projected for the year 2000 will be attained sooner. This will necessitate progression to the next planning stage at an earlier date.

Of equal concern is the potential for unexpected shifts in the pattern of population growth which may significantly affect the cost-effectiveness of a project. Regionalized collection and treatment systems are relatively unaffected by shifts in the geographic pattern of development which require only the construction of additional interceptors. Small-scale shifts in the pattern of development can be accommodated by local systems, but

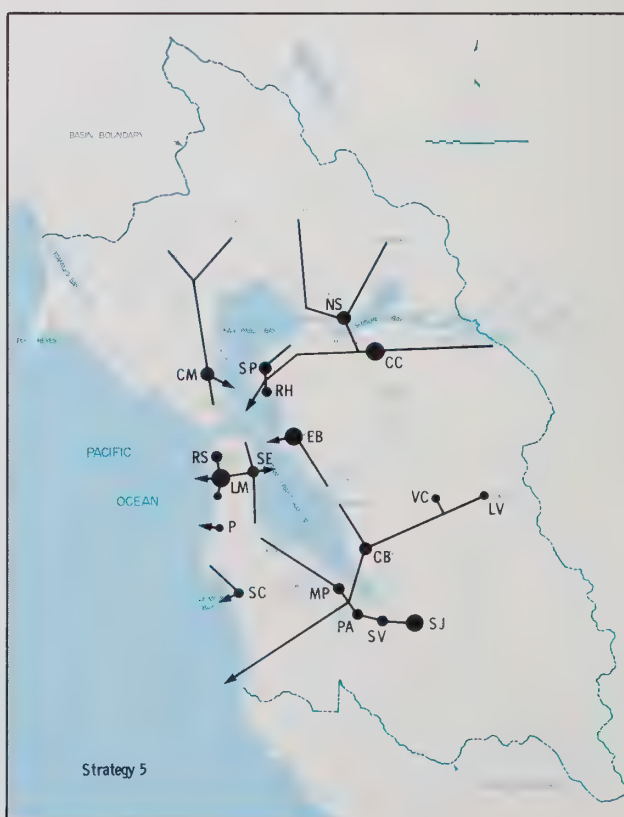
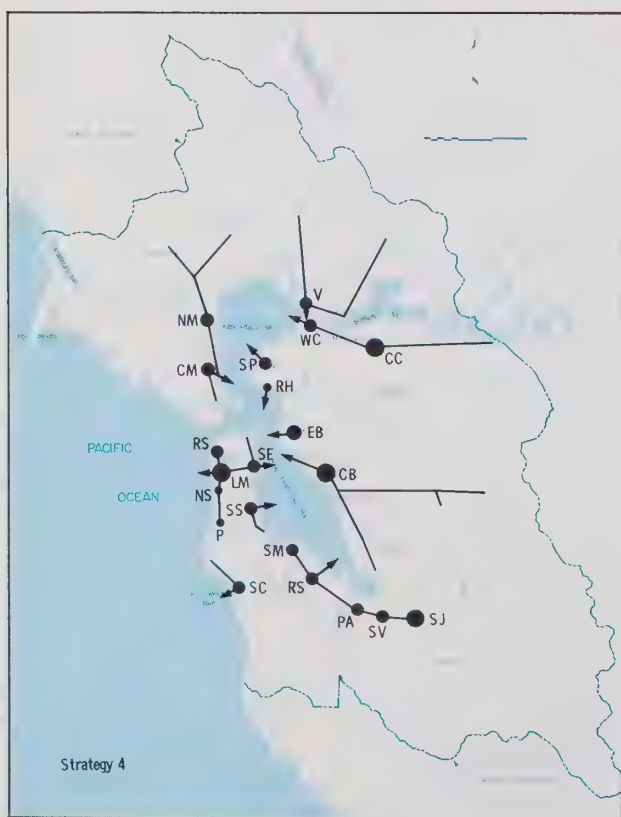
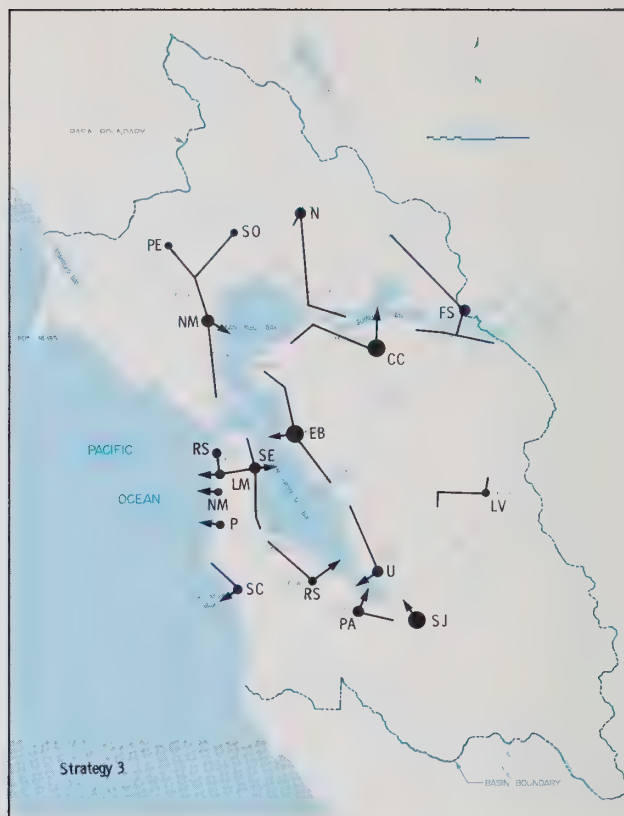


large-scale shifts can necessitate construction of new treatment facilities.

Strategy Analysis

Major environmental issues provided the bases for alternative formulation of basin planning strategies, which were then evaluated under variations in basinwide conditions. This was done in order to assess sensitivity of alternative systems to differing levels of urban development, to varying treatment requirements and to assure plan flexibility. By assuming variations to original estimates, a relative comparison in strategies was made and used as a basis for economically evaluating the subregional programs under a range of conditions.

Five planning strategies that were selected for analysis represent conceptual level formulation of projects, policies, and basin programs that are consistent with the principal issues discussed, and advance toward achieving the long-term goals of water quality objectives. The strategies, which represent alternative planning directions, describe the range in presently feasible planning approaches; they are identified as follows:



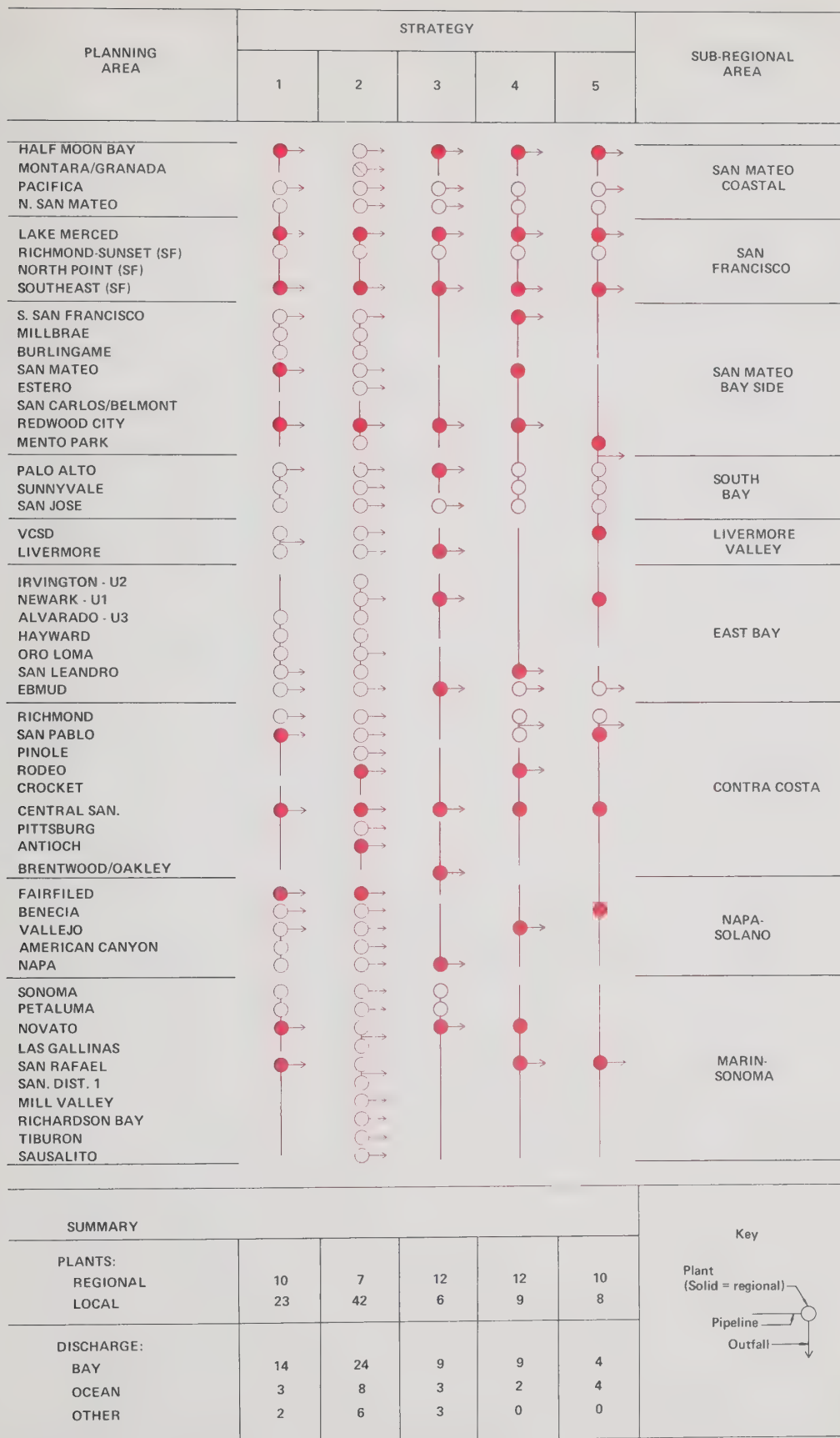


Figure 6. Schematic Layout of Strategy Networks

- Strategy 1. A composite of subregional study recommendations, termed the existing plan.
- Strategy 2. Limited consolidation of existing treatment and disposal facilities with retention of most local discharge systems now in operation.
- Strategy 3. Consolidation of facilities toward areas of potential wastewater reuse or land application with discharge of plant effluents to receiving waters in those areas.
- Strategy 4. Regional consolidation of treatment and disposal facilities with discharge away from the most environmentally sensitive receiving water areas (discharge toward Central Bay).
- Strategy 5. Regional consolidation of facilities with discharge to receiving water areas of greatest assimilative capacity (Central Bay and the Pacific Ocean).

The five feasible planning strategies, developed in enough detail to permit comparative evaluation of economic, functional and environmental factors, are portrayed schematically in Figure 6.

Analyses, based on evaluations of economic, functional and environmental issues, have tended to reinforce conclusions expressed in the various subregional studies regarding the appropriate degree of consolidation of wastewater systems and discharge locations which in essence, are represented by Strategy 1.

From a basinwide perspective all viable strategy alternatives to the existing composite plan present some economic, environmental, or functional disadvantages. It is concluded that continued discharge of wastewaters to San Francisco Bay, with treatment upgraded beyond present levels, is the most effective program for solution of existing and potential water quality problems in the Basin. Construction of deep water outfalls, interplant conveyance pipelines and additional treatment processes constitute the primary physical aspects of the near future programs. The degree of regionalization expressed for wastewater management operations is the best approach for initial development; strategies representing lesser consolidation result in a lesser probability of adequate environmental enhancement, are of questionable long

-term reliability, and do not yield significant cost savings over other alternatives. On the other hand, those strategies which involve greater consolidation than recommended are not found to be significantly more effective in improving quality of the Basin's aquatic environment. There are some significant environmental impacts associated with major consolidations which also compare unfavorably with the existing plans.

Amending the strategies to incorporate major reclamation features was also evaluated in order to determine financial sensitivity between alternatives to potential revision in disposal concept towards future reuse. It was found that the concepts of reclamation do not play a major role in dictating the most effective or optimal steps necessary to implement a sound and cost-effective wastewater management plan in the Basin in the near future and that all plans are flexible enough to accommodate future shifts in emphasis on reuse as opposed to discharge when economic and social factors merit.

THE RECOMMENDED PLAN

The Water Quality Management Plan for San Francisco Bay Basin includes a description of necessary wastewater facilities, nonpoint control measures, and additional control actions felt necessary to assist in implementation of the Plan. Although municipal wastewater treatment and disposal facility improvements are emphasized, additional control measures are recommended for industrial wastewaters, urban runoff, agricultural systems, construction activities and dredging operations within the Basin. Further control actions for the State and Regional Boards as well as other agencies associated with water pollution control are recommended, including a surveillance program for measuring the effect of the Basin Plan.

Facilities Requirements

In order to adequately protect the beneficial uses through compliance with water quality objectives and effluent limits, it will be necessary to continue construction and operation of water quality management facilities for most point source wastewaters; to control nonpoint source wastes, other means than construction of facilities must be primarily relied upon.

Collection, treatment, and disposal facilities for wastewater must be economically feasible, cost

Table 13. Recommended Treatment Levels^a

Receiving water segment	Initial treatment level
1 Pacific Ocean	Secondary
2 Central San Francisco Bay	Secondary
3 San Pablo Bay	Secondary
4 Suisun Bay and Western Delta	Secondary ^a
5 Lower San Francisco Bay	Secondary
6 South Bay	Secondary with partial nitrification
7 Suisun Marsh	Secondary, ^{a,b} no dry weather discharge
8 Napa River	Secondary with nitrification ^{a,b}
9 Petaluma River	Secondary with nitrification ^a
10 Sonoma Creek	Secondary with nitrification ^a
11 Alameda Creek	Secondary with nutrient removal, ^b no dry weather discharge
12 Richardson Bay	No discharge
13 Tomales Bay	No discharge

^a Possible future nitrogen removal.

^b Includes effluent final filtration.

effective and environmentally acceptable in addition to satisfying water quality objectives. Recommendations must be sufficiently flexible to accommodate future changes in technology, land development and legal requirements, as well as being acceptable to those charged with implementation of the plan, the public and the industrial community, who jointly bear the financial burden of necessary improvements. An acceptable program, while in compliance with all statutory effluent limitations and prescribed water quality objectives, must in addition assure support from local and regional entities. Much of the effort of facility planning was directed, at a reconnaissance level, toward assessing conceptual management strategies rather than detailed engineering evaluation of treatment plants, effluent disposal locations, or alternate routing of regional interceptors. Specific technical details can be better addressed at the facilities planning (project report) level of study. An overview approach was deemed appropriate because detailed project level planning has been or is being performed in many of the subregions of the Bay Basin, and it is most essential to establish at this time whether the ongoing programs are compatible with long-term wastewater management concepts and goals.

Municipal Facilities

Subregional agencies within the Basin have concluded feasibility investigations and many have

either completed or initiated the necessary detailed facilities plans for participation in federal and state construction grant programs. The Basin Plan for facilities improvement is shown in Figure 7. Subareas within which further study is being conducted in order to determine a final facilities plan are noted. In general, plants and transport systems shown for the areas are those consistent with current subregional planning. Treatment levels associated with specific water quality segments and consequently with the various facility elements of the recommended plan are given in Table 13.

Elements of the municipal facilities plan are discussed in the following sections. These discussions are organized under eight major subregional areas because of commonality of planning issues and for consistency with the geographical breakdown used in this and earlier studies. Within most of the larger subregions there are two or more subareas which comprise political jurisdictions or planning areas (some simply "spheres of influence") which form the most effective subdivision for major facilities planning and funding purposes. Subdivision into implementation level areas will not be precisely defined until each subregional program has progressed through the project report phase of planning into actual implementation. However, for purposes of this plan, the following subdivisions are defined:

Planning subregions	Subdivisions
Marin-Sonoma	South-Central Marin ^a North Marin-South Sonoma ^a
Napa-Solano	Napa Vallejo Benicia Fairfield-Suisun
Contra Costa	Western Contra Costa ^a Richmond Central-Eastern Contra Costa ^a
East Bay	East Bay MUD East Bay Dischargers ^a
Livermore-Amador Valley ^a	(No subdivision)
South Bay ^a	(No subdivision)
San Mateo	South San Mateo Bayside Central San Mateo Bayside North San Mateo Bayside North Coastal San Mateo Pacifica South Coastal San Mateo ^a
San Francisco	(No subdivision)

^aProbable further subdivision for implementation of local improvements.

As noted, some of the tabulated implementation subdivisions will be concerned only with major subregional works, while local improvements may be separately financed and operated by local sewerage agencies.

Marin-Sonoma Subregional Area. Consolidation of existing municipal wastewater treatment facilities to four locations near the communities of Petaluma, San Quentin, Sonoma, and Novato is recommended for the Marin-Sonoma subregion. New facilities (of a regional nature) would initially provide secondary treatment and convey effluent through two outfalls to discharge locations off Point San Pedro and Point San Quentin. A principal feature of the program is design of an interceptor outfall system for reverse flow, thus permitting future transport of treated effluent northward as reclaimed wastewater uses develop.

In the rural communities, continued use of individual sewage disposal systems (septic tanks) is recommended where determined to be feasible. The Regional Board has determined that serious threats to public health and receiving water quality exist at Stinson Beach in Marin County and the Glen Ellen and Penngrove areas of Sonoma County. Consequently, a prohibition of

discharge to individual leaching or percolation systems has been issued for those areas. The Glen Ellen and Penngrove areas should be sewerer to the treatment facilities of the Sonoma Valley County Sanitation District and the City of Petaluma respectively. The community of Stinson Beach and the more densely populated areas of the western Marin communities of Bolinas, Inverness, Olema, and Pt. Reyes Station should be served by community collection, treatment and land disposal systems.

Agencies responsible for wastewater management activities in the Marin-Sonoma subregion now have under consideration several viable alternative plans for water quality control. Analysis of planning strategies during this study indicate slightly higher capital costs for the recommended consolidation plan than for modified local treatment and disposal, however, assessments of environmental and functional factors appear to justify the relatively small increase in cost for an improved level of protection of beneficial uses.

It is suggested that additional facilities planning be undertaken by a joint planning group in connection with two specific areas of the subregion, to the north, the Petaluma and Sonoma area and, in the southern extent, the Sausalito and Tiburon Peninsula areas.

Napa-Solano Subregional Area. Separate treatment facilities at Fairfield, Benicia, Vallejo and Napa are recommended within this subregion. At Fairfield the plan entails use of effluent for agricultural purposes during the crop irrigation season with discharge to Suisun Marsh of plant effluent not needed for irrigation during wet weather months. Contractual arrangements have been made with the Solano Irrigation District to accept all Fairfield effluent during the period May 1st to September 21st, and a portion of the effluent during early winter periods. Part of the remaining effluent will be released to duck club ponds for flow augmentation. During the winter, effluent will be discharged to Suisun Marsh at Boynton Slough. The Fairfield project, which will be under construction by the end of 1974, will be carefully monitored for seasonal affect on the marsh ecosystem.

Secondary effluent from wastewater facilities at Benicia and Vallejo would be discharged locally in Carquinez Strait for conformance with water quality objectives. A feasibility-level report has been completed by the City of Benicia; a project

report is required this coming year prior to implementation of the proposed improvements. Treatment proposed by the Vallejo Sanitation and Flood Control District will utilize physical-chemical processes rather than biological treatment to produce a secondary quality effluent. Predesign studies by the Vallejo District indicate that all discharge requirements will be met. The Vallejo treatment plant construction will commence by the end of 1974.

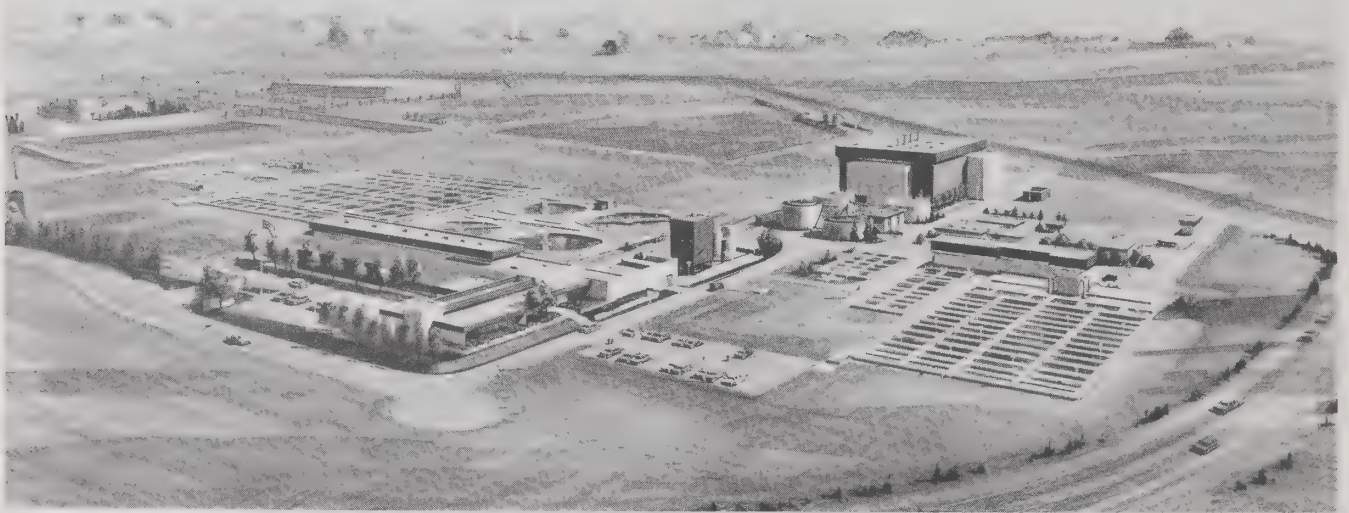
The Napa Sanitation District has proposed and received conceptual approval for discharge to the Napa River by utilizing existing oxidation ponds for nitrification and some nitrogen removal by providing chemical flocculation-sedimentation followed by filtration for algal removal from pond effluent. The proposed system should effectively mitigate DO depression in the river but will not necessarily avoid the advancing eutrophication problems caused by agricultural and municipal nutrient loads. An ongoing monitoring program will be conducted to assess the long-term acceptability of the upgraded Napa discharge. If future transport of wastewater out of the river is deemed necessary, the upgraded Napa effluent will be suitable for discharge to the Vallejo outfall as an alternative without further treatment as shown in Figure 7. The Napa system will accept oxidation pond effluent from the American Canyon area for combined treatment and disposal.

Retention of existing separate facilities and land disposal at Calistoga, St. Helena, and Yountville is

recommended for the upper Napa Valley communities. Effluent from these systems should continue to be used for agricultural purposes, including irrigation and vineyard frost protection. Project reports are needed for these subareas when treatment capacity or disposal facilities are found necessary.

Contra Costa Subregional Area. Since completion of the Contra Costa County Water Quality Study in September 1972, additional water quality management planning has proceeded on a subarea basis within the county; specifically within the western, central, and eastern county areas. Acknowledging the present situation, the recommended water quality management plan for Contra Costa is presented for each of the three geographical areas.

The recommended plan in the western area, that portion of the county adjacent to San Pablo Bay abutting the Berkeley Hills, consists of wastewater conveyance by new interceptors to secondary treatment facilities for effluent disposal to San Pablo Bay. Two treatment facilities are envisioned; one at Richmond and a second at San Pablo. These are both existing treatment plant sites. At present, water quality conditions in San Pablo Bay are not considered a problem which allows initial emphasis on construction of an interceptor system while the consolidated treatment facilities can be scheduled later in the design period. A western county Joint Powers Agency is currently reviewing earlier recommendations and



Artist's Rendition of CCCSD Plant now under Construction

preparing a facilities plan to be submitted later this year.

All wastewaters generated in central Contra Costa County are to be conveyed to a regional treatment facility near Pacheco where a minimum of secondary treatment will be provided prior to discharge to Carquinez Strait near the Martinez Bridge. Considerable potential for wastewater reclamation exists in this portion of the county as industries along the south shore of Suisun Bay require substantial quantities for process and cooling water demands. The current joint water reclamation program of the Central Contra Costa Sanitary District and the Contra Costa County Water District involves construction of the necessary facilities for an initial wastewater reclamation plan for industrial reuse.

Original recommendations for wastewater management in Contra Costa County included transport of eastern county wastewater to the regional facilities near Pacheco for treatment, reclamation and disposal. Eastern county agencies are presently reconsidering this recommendation and are about to authorize preparation of a facilities plan to be submitted in late 1975. Timing is critical for most eastern county dischargers, as several are at or near design capacity. An eastern county joint powers agency has been formed to prepare the plan and project report. Based on planning strategy analysis, two options appear feasible for the eastern county area. One provides for conveyance of all wastewaters to Pacheco, while the other provides for a separate treatment facility in the Pittsburg-Antioch area. The more rural communities east of Antioch may have additional local options for land disposal or agricultural reuse.



Effluent from the Livermore Plant is used to irrigate pasture and a golf course

Any recommended plan, must incorporate at least secondary treatment, provide for industrial participation where feasible, and remain sufficiently flexible to assist in the development of the several major potential uses for reclaimed wastewaters which exist in the area.

Livermore-Amador Valley Subregional Area. The recommended plan for Livermore-Amador Valley entails maintenance of the Livermore and Valley Community Services District (VCSD) treatment facilities, with conveyance of wastewaters from the overloaded Pleasanton plant to VCSD. During the initial operating stage, salt concentrations and other water quality parameters in the Niles Cone groundwaters and Alameda Creek would be care-



Artist's Rendition of East Bay MUD Plant now under Construction

fully monitored and evaluated to determine potential degradation possibilities while existing quality would be maintained by the release of South Bay Aqueduct waters.

At present, two disposal options seem viable, both entailing Valley-wide consolidations. To conform to the recommended dry weather discharge prohibition to Alameda Creek, either export of wastewaters out of the Valley by pipeline, or a storage reservoir-routing operation are recommended. Both options are time-dependent and cost-intensive, which implies major concern with implementation aspects of a Valley-wide program to avoid potential water quality impairment.

The relative merits of these options are presently being assessed through a project report study being carried out for the Livermore-Amador Valley Water Management Agency (LAVWMA).

East Bay Subregional Area. In order to maintain water quality objectives, treatment facilities in the East Bay need upgrading to full secondary treatment level. Upgrading of treatment facilities at Alvarado, San Leandro, Oro Loma and Hayward are required while Irvington and Newark would be phased out of service after the necessary expansions at the Alvarado plant are complete. The existing East Bay Municipal Utilities District treatment plant is presently being expanded and upgraded to secondary level with design capacity sufficient to adequately handle projected waste flow for the district.

Although EBMUD will continue to discharge through an existing outfall just south of the San Francisco-Oakland Bay Bridge, a new regional outfall will be designed to convey treated effluent from all remaining East Bay systems to a bay location offshore from the Oakland Airport. Similar in concept to the Marin-Sonoma system, the East Bay effluent conveyance system would be designed as a pressure pipeline for its entire length enabling effluent to be transported in either direction if the need arises in conjunction with developing water reclamation markets to the south. A facilities plan describing this program in detail has been submitted to the State Board for approval.

South Bay Subregional Area. Recommendations for improving water quality conditions in the southern reaches of San Francisco Bay have focused on removing point source waste loads

from shallow extremities of the South Bay. Existing facilities at San Jose-Santa Clara, Sunnyvale and Palo Alto will be upgraded to provide secondary treatment plus nitrification of effluent due to low assimilative capacity for oxygen demanding wastes in this reach of the Bay. Combined effluent from the three facilities would be conveyed to a location north of Dumbarton Bridge for discharge through a multiport diffuser for adequate dilution in the receiving water. To avoid foreclosure of future reclamation options, the conveyance pipeline will be pressurized to allow reversal of flow for maximum flexibility in meeting potential wastewater reclamation markets to the south.

Future wastewater reclamation by groundwater recharge in the South Bay remains uncertain until the significance of potential health hazards are clearly defined. Local reclamation projects such as the proposed salinity intrusion barrier at Palo Alto appear promising and should be investigated further.

San Mateo Subregional Area. Due to the Santa Cruz Range that divides the catchment basins of San Mateo County, wastewater systems are normally considered within two separate areas, those on the bayside and the smaller coastal districts.

The bayside areas are subdivided into three planning units. The communities of South San Francisco, San Bruno, Millbrae and Burlingame, as well as San Francisco International Airport, comprise the northern bayside unit. Plans for this area consist of a program for providing secondary treatment at all existing facilities whereby effluent will be collected from the individual plants and discharged through a common outfall near Point San Bruno into San Francisco Bay.

The central planning unit includes San Mateo and Foster City. The recommended program consists of abandoning the existing Estero Municipal Improvement District (Foster City) plant and conveying sewage to the San Mateo treatment facility which is to be expanded and upgraded to secondary treatment. The combined flows will be discharged through existing outfalls into San Francisco Bay near the San Mateo Bridge.

Belmont, San Carlos, Redwood City and Menlo Park, which comprise the southern bayside unit, are scheduled to abandon present facilities and convey wastewater from the respective service areas to a new regional wastewater treatment



Electrical Power Generation Facilities near Pittsburgh

plant at Redwood Shores. Wastewaters will receive conventional secondary treatment prior to discharge to San Francisco Bay offshore from Redwood Peninsula. Common to each planning unit along the bayshore of San Mateo County are water quality requirements for protection of seasonal shellfish harvesting. For all bayside programs, flexibility and reliability must be provided in new treatment facilities for the protection of shellfish beds along the Bay shoreline.

On the coastal side of San Mateo County, most existing wastewater treatment facilities will be upgraded to secondary level. Effluent disposal options at individual facilities should remain flexible to permit the use of reclaimed effluent for local irrigation, and other potential uses of reclaimed wastewaters. Disposal will normally be accomplished through ocean outfalls with diffusers designed to achieve high initial dilution. Treated effluent from North San Mateo County Sanitation District will be conveyed either to the proposed Lake Merced outfall under consideration by the City and County of San Francisco or discharged through their existing outfall which can be modified to accommodate future flows with higher dilution. Existing outfalls at Pacifica and Half Moon Bay will be retained, the latter to also serve the Granada and Montara area where existing primary plants will be abandoned. Disposal options for Half Moon Bay may include the possibility of groundwater recharge for agricultural reuse; investigations are now being con-

ducted to determine the most economically feasible solution.

San Francisco Subregional Area. Unique wastewater management solutions are required for San Francisco because of major problems inherent in its combined sewer system and the location of its treatment and discharge systems. The recommended program for San Francisco as developed by the City and County of San Francisco consists of two phases—one for the treatment of dry weather flow and another for supplemental conveyance, storage and treatment of all incremental wet weather flows. Design and construction of these programs is scheduled over a long time frame owing to substantial (\$650,000,000) capital cost for the complete program.

Phase I is designed to provide secondary treatment at Southeast and Richmond-Sunset plants and to reduce wet weather overflows in critical beach areas along the north shore and ocean. Dry weather flow from the North Point plant will be pumped to the Southeast plant for treatment. Secondary treatment will be provided for the combined dry weather flow while treated effluent will be discharged to San Francisco Bay through an improved outfall offshore from China Basin. Retention basins will also be constructed during Phase I to provide storage for wet weather overflows from the North Shore areas. Wastewaters diverted into these retention basins during wet weather will subsequently be treated at the exis-

Table 14. Summary of Costs for Recommended Municipal Wastewater Treatment Facilities

Subregional area	Capital costs, ^b million dollars		Operation and maintenance costs, million dollars/year		Total annual costs, ^c million dollars/year
	1st stage	Total	1975-1984	1985-2000	
Marin-Sonoma	68	85	1.6	2.0	6.1
Napa-Solano ^d	37	69	1.8	2.4	5.2
Contra Costa	47	68	2.2	2.4	5.4
East Bay	79	91	4.2	4.5	9.0
Livermore Valley	23	49	1.4	2.3	3.7
South Bay	76	86	4.7	5.3	9.4
San Mateo					
Bayside	35	42	2.4	2.6	4.8
Coastal	13	15	0.7	0.8	1.6
San Francisco ^e	219	570-940	4.9 ^f	8.7 ^f	-
Total	597	-	23.9	31.0	-

^a Values for Strategy 1 configuration.

^b Based on ENR Construction Cost Index of 2000; includes construction cost plus all engineering, legal and administrative fees.

^c Based on an amortized capital cost for facilities construction between 1975-2000 plus annual operation and maintenance.

^d Revised to provide nitrogen removal at Fairfield.

^e San Francisco Master Plan.

^f Cost data provided by Division of Sanitary Engineering, City and County of San Francisco.

ting North Point plant, converted to treat only wet weather flows. The Richmond-Sunset treatment facility will be upgraded to provide secondary treatment with a new interceptor/outfall constructed for discharge offshore from Lake Merced.

In phase II, retention basins will be constructed to provide necessary storage and treatment for wet weather flows throughout the remainder of the system. The bayside outfall from the Southeast plant will be abandoned and secondary effluent from both the Southeast and Richmond-Sunset treatment plants will be pumped to Lake Merced and discharged through the ocean outfall. During wet weather conditions, flows exceeding the capacity of the plants will be pumped to a new wet weather treatment facility at Lake Merced for subsequent discharge through the ocean outfall.

Financial and Institutional Aspects. As part of any implementation program, all agencies must develop financial resources to construct and operate necessary facilities. A summary of costs on a

subregional basis is presented in Table 14 for municipal facilities. Table 15 presents an initial implementation schedule for each subarea by which funding requirements can be estimated.

Industrial Facilities

In general the alternatives available to industrial dischargers are the following: (1) abandonment of present wastewater facilities and connection to municipal sewerage systems; (2) discharge to receiving waters in compliance with NPDES permits issued by the Regional Board and the Environmental Protection Agency; and (3) containment and evaporation of industrial wastewaters on land. Of the 120 discrete industrial dischargers which will require discharge permits, EPA has presently promulgated effluent guidelines which are applicable to only 19. These include six petroleum refineries, six steam electric power generating stations and seven petrochemical plants which include fertilizer and phosphate manufacturers. Even for those cases where federal effluent guidelines exist, the formulation of permit requirements remain a complex matter. In

Table 15. Implementation Schedule^a

Planning subregion	Subdivision	Implementation elements			
		Facilities plan	Initial facility design	Construction	Operation
Marin-Sonoma	South-Central Marin	1975	1976	1977	1979
	North Marin-South Sonoma	1975	1976	1977	1979
Napa-Solano	Napa	Approved	1975	1975	1977
	Vallejo	1975	1975	1976	1978
	Benicia	1975	1976	1976	1978
	Fairfield	Approved	Completed	1974	1976
Contra Costa	Western Contra Costa	1975	1976	1977	1979
	Richmond	1975	1976	1977	1979
	Central-Eastern Contra Costa	1975	1976	1977	1979
East Bay	East Bay MUD	Approved	Completed	Underway	1976
	East Bay Dischargers	Completed	1975	1975	1977
Livermore-Amador Valley		1975	1976	1977	1979
South Bay		1975	1976	1977	1980
San Mateo	South Bayside	1974	1976	1976	1978
	Central Bayside	Completed	1975	1975	1977
	North Bayside	Approved	Completed	Underway	1975
	North Coastal	Completed	1975	1975	1977
	Pacifica	1976	1977	1977	1979
	South Coastal	1975	1976	1976	1978
San Francisco		1975	1977	1977	1980

writing a permit the Regional Board must consider the identified beneficial uses in the proximity of discharge as well as federal guidelines.

This has resulted in some cases of more restrictive limitations than promulgated by federal guidelines. For example, the requirement for limitations on toxicity of the effluent are not included in any of the published federal requirements. Some plants will be required to collect and treat runoff from contaminated areas in addition to normal process wastes, and requirements for cooling waters may also be included as necessary to protect beneficial uses of the receiving waters affected by industrial discharge.

The Basin Plan does not include specific recommendations regarding the consolidation of industrial and municipal discharges. The economics of heavy industrial dischargers incorporating with municipal treatment plants was not carried to sufficient detail to draw conclusions regarding the viability of such combined industrial-municipal systems. The degree to which basin planning objectives are met is not relatable to this issue; it

is appropriate that the main burden of decision-making in this matter rest with individual major industries.

Agricultural Drainage Facilities

The only significant agricultural point source waste load to Bay Basin waters stems from the proposed San Joaquin Valley Drain which will transport irrigation wastewater from the Central Valley to the western Delta near Antioch.

Agricultural irrigation in the San Joaquin Valley contributes to high groundwater levels and subsequently high saline and nitrogen conditions in the soils. To alleviate this condition, tile drains have been proposed which would be connected to joint State-Federal master drainage facilities. These facilities consist of conveyance elements from the San Luis Service Area, Basins 5B and 5C, and the Tulare Lake Basin (Basin 5D) to Kesterson Reservoir north of Los Banos. Storage of drain wastewaters would occur until the reservoir is filled, at which time discharge would be through additional facilities into the Delta near Antioch. The Central

Valley Basin Water Quality Management Plan recommends construction of the Drain because of benefits to the San Joaquin River, southern Delta and to groundwater basins served.

Nitrogen concentrations may result in increased algal productivity in the vicinity of Drain discharge dependent upon depth of light penetration (turbidity) under future (year 2000) agricultural waste loads. This case, derived from mathematical modeling results, may imply regulation of Drain flows during critical periods of the year, nutrient removal from this source or from municipal and industrial wastewaters, or relocation of discharges if found more cost-effective.

Additional study and assessment of potential effects are necessary, continual monitoring should be part of project implementation and, as Delta operations are modified, re-evaluation of possible adverse effects must be made. If the euphotic zone is not found to alter significantly with future Delta controls on water releases to the Bay, it is concluded that agricultural drain discharge at Antioch will not seriously affect the estuarine water quality.

Solid Waste Management

The protection of water resources requires consideration of solid waste management practices. While water quality problems associated with

solid waste disposal have been insignificant in comparison to wastewater loads historically, the potential for such problems to occur in the future unquestionably exist. This is due, in part, to the large volume of waste generated within the urban core of the Basin and the lack of existing and future sites for disposal operations. Only three locations have been designated by the Regional Board as Class I disposal sites although the volume of material which is restricted to such sites for disposal increases at a faster rate each year. As higher levels of treatment are required to meet water quality objectives, additional solids will be generated further taxing presently limited disposal site capacity.

At present, many agencies are at a critical point in determining future methods of sludge disposal. The landfilling of digested sludge or incineration with ash disposal is extensively used in the Bay Area, while land disposal is mainly practiced at small treatment plants. Land disposal, found to be economically competitive at a feasibility planning level, should be evaluated seriously in future subregional projects. Factors requiring more detailed study are potential site locations and the effect of sludges on soils, crops, groundwaters, and surface waters. If land disposal operations are found favorable from a technical standpoint, then some form of regional organization should be formed to administer and regulate operations.



Another alternative which should seriously be considered is the combined incineration of municipal sludge and solid wastes. This system can result in additional energy production and resource recovery. There are few installations of this type operational in the U.S., but the potential exists to utilize recent developments and the wealth of experience obtained in Europe.

Wet Weather Overflows

During any storm, contaminants enter receiving water from several principal sources which include sanitary and combined sewer overflows, urban and nonurban runoff, and municipal and industrial treatment plant effluents. Data reviewed in the Basin Plan study indicate that urban and nonurban runoff contribute a significant amount of pollutants. Although management of runoff poses unique problems, control measures for nonpoint sources are possible. Bacteria are the major constituent of concern from wet weather overflows. Future control actions must principally concentrate on reducing the public health hazard associated with high bacterial concentrations which can adversely affect water related recreation and shellfish harvesting. Such beneficial uses also require elimination of physical evidence from untreated wastewaters in nearshore and shoreline waters.

The proposed approach for control of wet weather overflows utilizes a common rainfall-intensity-frequency procedure used for storm runoff control problems in conjunction with alternative levels (termed levels of maintenance) for protection of beneficial uses. In the Bay Basin most precipitation occurs during the winter months of November to March. Conversely, most recreational activities occur from April through October. In water segments where contact recreation and/or aesthetic enjoyment are to be safeguarded, protection must be most stringently assured during the recreation season. In some areas, year-round protection may be mandatory. Shellfish harvesting requires year-round protection, although at present, urban stormwater runoff creates adverse conditions for winter harvesting. Each segment of the Basin has specific characteristics and resultant beneficial uses to be protected on a seasonal and/or annual basis.

Rainfall return period, the reciprocal of storm frequency, is utilized to determine the necessary treatment level and capacity for a given alternative level of maintenance. It is proposed that for

each maintenance level, treatment requirements be established for all flows generated by specified storms. Maintenance Level A provides maximum protection is attained by secondary treatment for all flows. This level is appropriate for areas where the aquatic environment should be free of any identifiable risk from the discharge of untreated wastewaters. Maintenance Level B is a condition where the aquatic environment is protected from significant impairment by sound water quality management practices. Maintenance Level C is a condition where aquatic productivity is limited due to the effects of a dense human population which may not be completely controllable.

In areas which warrant Maintenance Level B or C protection, some controllable risk of degradation is allowed. Consequently, varying treatment levels are recommended at different rainfall return periods. With intense storms, the level of treatment may be decreased since the aquatic environment along shorelines may be significantly affected by increased flows, turbulence, turbidity and other physical characteristics. Within those areas which require Maintenance Level B, it is recommended that secondary treatment be provided for wastewater flows associated with a 2-year storm. Excess flows up to that generated by a 20-year storm should receive the equivalent of primary treatment with disinfection. Corresponding values for those areas designated as Maintenance Level C, would be: secondary treatment for flows generated by a 0.5-year storm (2 storms per year) and primary treatment with disinfection for excess flows caused by the 5-year storm. More intense storms would result in untreated overflows.

Water quality objectives require that all outfalls achieve an initial dilution of 10:1 in order to minimize adverse aesthetic effects of discharge, especially that of untreated or partially treated overflows. It is recommended that any possible wet weather overflow, whether from a separate or combined system, should receive coarse screening to remove large visible floating material and to protect the outfall system than be discharged through outfalls which satisfy the 10:1 dilution objective. Overflow locations should be in areas where discharge will cause minimal effects on beneficial uses. Removal of such overflow locations from dead-end sloughs and channels, and close proximity to marinas and land beaches is especially desirable. In no case shall untreated or partially treated wet weather discharges be tolerated where local currents or confinement will

result in accumulations of floatable materials. Uncontrolled bypassing from collection systems is prohibited in all cases.

Nonpoint Source Measures

Waste loads from nonpoint sources include those originating from agricultural operations, individual waste disposal systems, construction activities, urban runoff, vessel wastes, oil spills and dredging. Control of these diffuse waste loads in the Bay Basin can entail actions in any of the following categories: (1) changes of existing operating practices, (2) collection and treatment of wastes, and (3) prohibition of waste generating practices. Before action is taken, diffuse source problems must be adequately assessed. It is recommended, that new control actions be preceded by the detailed investigation of waste and receiving water relationships to accurately determine cause and effect of specific nonpoint source pollution problems.

Agricultural Wastewater Management

Agricultural wastewaters and the effect of agricultural operations are a result of land use practices, and effective controls should be developed in the agricultural element of land use plans. Improvements in agricultural practices are recommended recognizing that federal-state permit programs will regulate certain agricultural activities.

Agricultural activities of primary importance in the Basin pertain to animal confinement practices such as feedlots and dairy corrals that have presented localized surface runoff problems in the Bay Area. Storm runoff that passes through farming operations may contribute manure loads to surface streams tributary to the Bay. Stockpiled manure may also add to the problem. Suggested controls presented in guidelines issued by the State Water Resources Control Board include containment of washwater, especially from barns, and surface drainage with disposal to adjacent lands or to approved treatment systems. All retention basins containing manure wastes should be protected from overflowing by flood flows. Management techniques may include routing of washwater and drainage to impervious areas, selecting more impervious soils, or paving, at manure storage areas, and applying manures and wastewaters on land at reasonable rates for minimal percolation.

Individual Disposal Systems

Septic tank systems and other similar methods for home waste disposal are sometimes viewed as interim solutions in urbanizing areas of a basin yet may be required to function for many years. The reliability of these systems is highly variable depending on land and soil conditions as well as individual maintenance which is often haphazard and rarely controlled after initial installation and inspection by local agencies. Usual septic tank system maintenance entails solids removal following a major failure of the system. Failures that bring most rapid attention are the result of blocked plumbing, backup of sewage into the home, and septic tank liquids surfacing on the ground, all of which cause nuisance odors and potential health hazards.

Individual disposal systems can be operated with relative ease when they are designed for a particular site. Regulations generally provide for good design and construction practices, and permit systems requiring periodic inspection and maintenance can be made a condition for building. A more troublesome problem is that presented by older existing septic tank systems where design and construction may have been less strictly controlled and where land development has intensified to an extent that percolation systems are too close together and there is no room left for construction of replacement leaching areas.

If septic tank systems in urbanized areas are not scheduled for replacement by sewers and public health hazards are not documented, septic tank maintenance procedures are encouraged in order to lessen probability that a few highly noticeable failures do not force sewerage of an area which, properly maintained, could be retained on individual systems without compromising water quality. Improvements of this type should be enforced by a local septic tank management district or by the county.

New septic tank systems should generally be limited to areas with a minimum parcel size of about one acre, except where soil and other physical conditions are particularly favorable. In these cases, physical constraints should be principally related to depth of water table, depth of soil, depth to impervious materials, ground slope and presence of water courses. Septic tanks and leaching systems should not be planned for any areas where it appears that the total discharge of leachate (under fully developed conditions) to the

geological system will likely cause damage to public or private property, degrade groundwater or create a nuisance or public health hazard.

Disposal of septage, the solid residue pumped from septic tanks, must also be accomplished in a manner acceptable to pollution control and public health authorities. Disposal may be to either a dump site which can accept liquid wastes, or discharge to a municipal treatment facility. In the latter case, chemical toilet wastes and other toxic septage should not be accepted at municipal plants; as they can harm biological treatment processes and reduce plant reliability. These wastes should be contained in appropriate dump sites.

Unsewered areas that have existing development with small lots (less than one-acre parcels) should be administered by a local septic tank maintenance district, preferably established by county government. These special districts could be administered through existing local governments such as a County Water District, a Community Services District, or a County Service Area. In several cases within the Basin, densely populated areas may be required to be sewerred in the near future; however, the inauguration of septic tank maintenance district programs could assure sewerage facility planning tailored to community need.

It is recommended that the Regional Board prepare guidelines for location, construction and maintenance of individual treatment systems within the framework concept of phasing out poor septic tank systems in areas where serious problems can be documented and where projected population densities warrant it. Engineering studies will be needed, in many cases, to determine the most effective solution to specific problems of an area which has outgrown its septic tank system.

Construction Activities

Construction and associated activities which may disturb or expose soil or otherwise increase susceptibility of land areas to erosion are difficult to regulate effectively. Construction may often begin and end with no obvious impairment of water quality; however, later erosion or land slides may be directly related to earlier land disturbance or clearing of natural ground cover.

Land sensitivity to erosion can be assessed before construction is permitted. Environmental con-

straints can be identified for use in screening permits and should be a basis for adding special conditions to waste discharge requirements where applicable. Cooperation of local approving agencies should be obtained in order that approvals of significant subdivisions in environmentally sensitive areas, particularly near marsh lands and riparian habitats, include appropriate conditions for the protection of water quality. For example, proposed subdivisions of 50 lots or more than can affect surface waters should be (1) covered by environmental impact reports on development and its impact on waste loads and water quality, (2) be in conformance with regional or county master plans, and (3) include provisions for establishment of a public agency responsible for environmental monitoring and maintenance where such subdivisions are outside other appropriate public jurisdictions.

Urban Runoff Management

The effects of urban runoff on receiving water quality is an issue which has only recently been considered from the standpoint of mitigation and control. Presently, much of the work has centered on characterizing urban runoff; concentrations of various constituents have been measured, attempts to relate these to such factors as land use type and rainfall intensity have been made, and studies concerning the amount of constituents present on street surfaces have been conducted. It appears that considerable quantities of contaminants, heavy metals in particular, may enter the receiving waters of the Bay Basin through urban runoff.

There are four fundamental approaches to control of pollutants from urban runoff: (1) prevent contaminants from reaching urban land surfaces, (2) improve street cleaning and the flushing of other areas where significant amounts of contaminants may be present, (3) treat runoff prior to discharge to receiving waters, and (4) new controls on land use and development. Which approach or combination of approaches is most effective or economical for a given urban setting has never been extensively considered.

Solutions to the problem of preventing water quality degradation by urban runoff are only in the earliest stages of development and consist mostly of plausible hypothesis on how to deal with the problem. Therefore, it is not presently possible to recommend a definite urban runoff control plan for the Basin. Research and study,

which up to now, has emphasized definition and characterization of the problem, shall now turn to developing alternative methods of control. The Federal Water Pollution Control Act Amendments of 1972 state specifically that the Environmental Protection Agency is authorized to conduct and assist studies "which will demonstrate a new or improved method of preventing, reducing, and eliminating the discharge into any waters of pollutants from sewers which carry storm water . . ." It is recommended that information continue to be collected and studied so that a workable and effective plan can be prepared in future years.

Vessel Wastes

Sewage discharges from commercial and pleasure boats have been the cause of some localized water quality problems in the past. Existing regulations require on-board waste holding tanks, but the scarcity of shore facilities to pump out waste has offset much of the effectiveness of this regulation.

The California Assembly now has before it a bill requiring marine sanitation devices, including holding tanks, plus the installation of pumpout facilities at marinas. Marinas may hook into municipal systems or install large holding tanks and dispose of the effluent at specific landfills. The installation of approved marine sanitation devices will be a necessary prerequisite for the required vessel registration with the California Department of Motor Vehicles.

The provision of new shore facilities at marinas and public piers for receiving wastes from pleasure craft and commercial vessels is considered a necessary adjunct to the control measures now in force.

Oil Spills

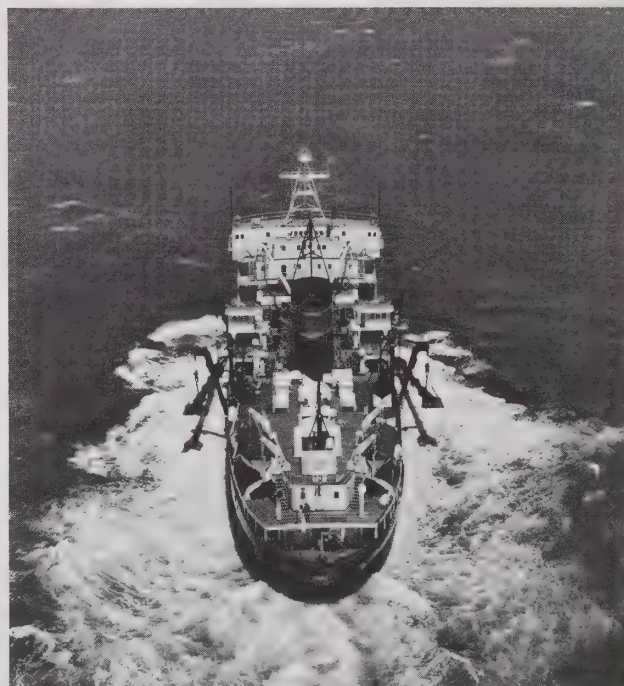
Actions in regard to this water quality problem refer to both minor spills and the question of major catastrophic spills from large tankers in the Bay and along the coast. To prevent oil spills at refineries and related shore facilities, the Environmental Protection Agency has issued detailed regulations pertaining to "non-transportation related onshore and offshore facilities." These regulations found in the Federal Register, December 11, 1973, should be pursued by the owners of facilities and the responsible control agency should police and enforce their implementation.

Dredging and Dredge Spoil

Dredging by itself produces minimal water quality problems in comparison to disposal of the dredge materials. Dredging problems are generally localized and of temporal nature involving upset of local benthic organisms, turbidity, decreased dissolved oxygen concentrations, and increased toxicity. Disposal of dredge spoils in nearshore marine waters, however, is an activity that must receive further study and research prior to recommending specific solutions. Dredging technology has changed little in the past few decades and the U.S. Corps of Engineers, Environmental Protection Agency, and several universities are presently performing research on the effects of dredging operations and new methods of dredge spoil disposal.

Criteria have been established to judge chemical characteristics of dredged material for disposal in marine waters. Additional factors must also be evaluated on a case-by-case basis in order to determine final suitability for disposal of a specific kind of dredge material at a given location. These factors include the following:

1. Volume of dredge material.
2. Existing and potential quality and use of the water in the disposal area.



Dredging across the San Francisco Bar

3. Other conditions at the disposal site such as depth and currents.
4. Time of year of disposal (in relation to fish migration and spawning, etc.).
5. Method of disposal and alternatives.
6. Physical, chemical, and biological characteristics of the dredged material.
7. Likely recurrence and total number of disposal requests in the receiving water area.
8. Predicted long and short term effects on receiving water quality.

It is recommended that the final EPA regulations in regard to "Transportation for Dumping and Dumping of Material into Ocean Waters" which were issued in October 1973 be effectively enforced. These regulations prescribe in detail the type of permit and environmental assessments required, the restrictions on the quality of the material to be dumped, as well as the locations, timing and procedures for disposal of dredge spoil disposal.

Recommended Control Actions

Comprehensive water quality management planning includes more than an assessment of point and nonpoint source wastewater control features. Wastewater management plans often recommend physical and institutional arrangements without adequate concern for actions needed on the part of governmental agencies. Existing government policies have been reviewed and are generally adequate, however, further regulatory and control actions are required for more effective water quality management. Consequently, the following policy modifications and needed actions are recommended.

State Water Resources Control Board

1. Water quality control programs must continue to emphasize total water resource management to the extent necessary for assurance of protection to all designated beneficial uses.
2. Water quality and quantity data collected by all governmental agencies should be systematically processed to facilitate timely and orderly analysis, storage, and retrieval. The monitoring, surveillance and data manage-

ment programs proposed by the State Board should be implemented as soon as possible.

3. Recognizing the ecological sensitivity of the Sacramento and San Joaquin Rivers and Suisun Bay and the ability of mathematical modeling to provide only broad characterization of water quality, it is recommended that a thorough evaluation of the effects of an agricultural drain discharge be initiated. This evaluation should include effect on the immediate area surrounding the discharge including initial dilution capabilities of the drain. In addition, the current Delta-Suisun Bay Surveillance Program should be supported and expanded to include a thorough evaluation of the effects of turbidity and nutrient concentrations on eutrophication. The Board should, furthermore, initiate studies to predict the effect of reduced Delta outflow on sediment transport, turbidity, and algal response. It is also recommended that the thermodynamic balance of the lower Delta be further evaluated in regard to the effect on migratory fish and shrimp.
4. Indicating strong evidence that certain pesticides constitute an unacceptable risk for producing cancer in humans, the EPA has recently ordered a halt to production of the two most widely used pesticides in the United States—aldrin and dieldrin. Continued vigilance, however, is necessary to insure other carcinogenic chemicals are not substituted in their place. It is recommended that the State Board urge EPA and the National Cancer Institute to continue to monitor for evidence of potentially carcinogenic material in the food chain and initiate control measures as necessary to ensure protection of human health and the environment. Such control measures must place emphasis on "hard" pesticides to effectively meet an objective of nondetectability in the aquatic environment.
5. The Water Quality Control Plan for Ocean Waters should be reviewed and revised, prior to enforcement of the implementation schedule contained in resolution No. 74-5. Such review should include comparison of numerical limits for total chromium, ammonia and toxicity concentrations with the Proposed Criteria for Water Quality and the Proposed Water Quality Information as published by the EPA pursuant to Public Law 92-500.

6. Assessment of environmental and economic impact for all new statewide water quality policies should be prepared. Although it is recognized that such policies are legally exempt from this procedure by the California Environmental Quality Act, they do result in implementation of programs involving major economic and environmental impacts and should undergo formal assessment by the State Board.
7. Water rights policies and decisions should reinforce water quality goals and objectives for all waters, and should include assessment of the feasibility of wastewater reuse. Adjudication of degraded groundwater basins should be considered as a tool for implementation of groundwater quality goals.
8. Water quality control policies should be prepared for all interbasin waters. Water quality conditions in the western Sacramento-San Joaquin Delta require special attention. Various differences exist in permit requirements and enforcement actions between Regions 2 and 5. Since environmental and water quality factors do not warrant differences, consistency of policy and action across the basin boundary is called for.
9. Water reclamation and reuse programs for supplemental water use should receive continued emphasis, including grant support, in all areas where additional water development projects are needed and where water demands are generally satisfied by imported waters. The proposed interagency committee and consulting panel on health aspects of wastewater reclamation should begin work immediately and be charged with the responsibility of formulating a specific action plan for needed research.
10. The Resources Agency should develop realistic water development cost data for comparison with water reuse projects.

Regional Water Quality Control Board

1. Water quality conditions must be monitored and evaluated. Consequently, all data from dischargers, and governmental or research agencies should be collected and incorporated in the recommended data processing program. An annual report should be prepared which would summarize and evaluate existing water quality conditions.
2. The water quality segments should be the subject of extensive monitoring programs to



document water quality conditions, especially those related to eutrophication. Watershed control plans should be prepared for each segment. Each plan should assess the relative contribution of pollutants and effects from both point and nonpoint sources. Effective practical control measures should be developed for each identified major source.

3. The Regional Board should undertake an evaluation of the effect of urban and rural storm water drainage, especially the anticipated increase of heavy metal loads on receiving water quality.
4. Guidelines for control, minimum standards of design, construction, operation and maintenance of individual waste disposal systems should be adopted.
5. Basinwide minimum standards for erosion control, especially as related to construction activities should be adopted.
6. All shellfish bed areas should be periodically evaluated for water quality characteristics especially for those related to public health concerns. The Regional Board in conjunction with the Departments of Health and Fish and Game, should formulate policies for protecting shellfish beds, evaluating adverse conditions, and controlling commercial or public harvesting. Such policy should include defined procedures and harvesting restrictions for all shellfish beds within the Basin.
7. The Regional Board should prepare a wet weather overflow control policy which considers affect on beneficial uses. If the recommended approach contained in the Basin Plan is adopted, then Level of Maintenance categories must be designated for all receiving waters.
8. Future Clean Water Grant Priority Lists should include Petaluma and Sonoma Valley in the Marin County areawide facilities plan. Facilities plans are needed for the communities of St. Helena and Yountville, while Pacifica will need to be included for upgrading its facility to secondary treatment. All facility plans should evaluate the inclusion of nearby discrete industrial dischargers into a municipal system.
9. Discharge (NPDES) permit requirements should include statistical limits instead of

absolute numbers for all parameters for which variations are expected and are tolerable.

Discharge Prohibitions

Selected special considerations need to be applied as discharge regulations by the Regional Board over and above constraints established by water quality objectives and effluent limitations. The following provisions are proposed for certain discharges and activities influencing water quality.

It shall be prohibited to discharge:

1. Any wastewater which has particular characteristics of concern to beneficial uses:
 - a. Affecting ocean waters over rocky substrates or within 1000 feet offshore from the extreme low water line and where the waste will not receive a minimum dilution ration of 100:1 as it reaches the surface.
 - b. At any point at which the wastewater does not receive an initial dilution of at least 10:1.
 - c. Into any nontidal water or dead-end slough or similar confined water areas or their immediate tributaries.
 - d. To Tomales Bay, Drakes and Limantour Esteros or Bolinas Lagoon.

Exceptions to a, b, and c above will be considered for certain wet weather discharges and other discharges having a high initial dilution where an inordinate burden would be placed on the discharger relative to beneficial uses protected and when an equivalent level of environmental protection can be achieved by alternate means. Exceptions will also be considered where a discharge is approved as part of a reclamation project or where it can be demonstrated that environmental benefits will be derived as a result of the discharge.

2. All conservative toxic and deleterious substances above those levels which can be achieved by source control, to waters of the Basin.
3. Sewage-bearing wastewater, garbage, oil, litter, debris, or wastes of any nature from vessels to the waters of San Francisco Bay,

Tomales Bay, Bolinas Lagoon, Drakes and Limantour Esteros, and Princeton Harbor.

4. Floatable rubbish, refuse, bark, sawdust, or other solid wastes into surface waters or at any place where they would contact or where they would be eventually transported to surface waters, including flood plain areas.
5. Floating oil or other floating materials from any activity in quantities sufficient to cause deleterious bottom deposits, turbidity or discoloration in surface waters.
6. Silt, sand, clay or other earthen materials from any activity in quantities sufficient to cause deleterious bottom deposits, turbidity or discoloration in surface waters or to unreasonably affect or threaten to affect beneficial uses.
7. Sludges to municipal or industrial waste origin and sludge digester supernatant, centrate, or filtrate directly to surface waters or to a waste stream that discharges to surface waters without further treatment.
8. Biocides of a persistent or cumulative form when applied over waters or near shoreline areas where direct or indirect discharge to water is threatened.
9. Radiological, chemical, or biological warfare agent or high level radioactive waste.
10. Oil or any residuary product of petroleum to the waters of the State, except in accordance with waste discharge requirements or other provisions of Division 7, California Water Code.
11. Any wastewater which has characteristics of concern to beneficial uses into San Francisco Bay south of the Dumbarton Bridge. Exceptions will be considered where the discharge is approved as part of a reclamation project or where it can be demonstrated that environmental benefits will be derived as a result of the discharge.
12. Sewage bearing wastewater to individual leaching or percolation systems in the Stinson Beach area of Marin County and the Glen Ellen and Penngrove areas of Sonoma County as specified in Resolution Nos. 73-13 (as amended), 73-14, and 73-19 of the California

Regional Water Quality Control Board, San Francisco Bay Region.

13. Untreated sewage to any waters of the Basin.

Discharge prohibitions contained in the State Water Resources Control Board's "Water Quality Control Plan for Ocean Waters of California" and "Water Quality Control Policy for Enclosed Bays and Estuaries of California" shall apply to all affected waters of the Basin.

Special discharge prohibitions are also recommended for enclosed bays and estuaries of the Basin.

1. New discharges of municipal wastewaters and industrial process waters (exclusive of cooling water discharges) to enclosed bays and estuaries, other than the San Francisco Bay-Delta system, which are not consistently treated and discharged in a manner that would enhance the quality of receiving waters above that which would occur in the absence of the discharge, shall be prohibited.
2. The discharge of municipal and industrial waste sludge and untreated sludge digester supernatant, centrate, or filtrate to enclosed bays and estuaries shall be prohibited.
3. The deposition of rubbish or refuse into surface waters or at any place where they would be eventually transported to enclosed bays or estuaries shall be prohibited.
4. The direct or indirect discharge of silt, sand, soil clay, or other earthen materials from onshore operations including mining, construction, agriculture, and lumbering, in quantities which unreasonably affect or threaten to affect beneficial uses shall be prohibited.
5. The discharge of materials of petroleum origin in sufficient quantities to be visible or in violation of waste discharge requirements shall be prohibited, except when such discharges are conducted for scientific purposes. Such testing must be approved by the Executive Officer of the Regional Board and the Department of Fish and Game.
6. The discharge of any radiological, chemical, or biological warfare agent or high-level radioactive waste shall be prohibited.

7. The discharge of by-passing of untreated sewage to bays and estuaries shall be prohibited.

Other Water Bodies. Three water quality limited segments of the San Francisco Bay which either presently experience pollution problems or are expected to do so with future wastewater discharge operations are of special concern with respect to the prohibition of dry weather discharges. It is recommended that the following discharge prohibitions be incorporated.

1. The direct discharge of wastewater shall be prohibited during the dry weather period of the year to the waters of the Suisun Marsh. The threat of high concentrations of toxicants, biostimulants, and oxygen demanding substances in an area of low assimilative capacity, great ecological sensitivity, and poor dispersion by tidal or fresh water flushing, merits such prohibition for the critical portion of the year when fresh water flows are nonexistent.
2. The direct discharge of wastewater shall be prohibited, from the portion of Richardson Bay lying between Sausalito Point and Peninsula Point. This area shows poor dispersion capability and a low assimilative capacity which have accentuated problems of coliform levels and biostimulation.
3. The direct discharge of wastewater shall be prohibited during the portion of the year when no natural flow occurs in Alameda Creek above Niles. The threat of dissolved solids, stable organics and other pollutants buildup in the groundwater of the Niles Cone area recharged with waters of Alameda Creek is most critical in the dry weather period when wastewaters may account for up to 20 percent of the water percolating to the basin.

Bay Area Sewer Services Agency

1. Prepare guidelines and model documents for use by municipalities and local sewerage agencies, including:

Sewer use and industrial waste ordinance.

Local source control procedures.

2. Evaluate the feasibility of conducting a basin-wide cooperative monitoring program which

would carry out the receiving water portion of monitoring requirements imposed on individual dischargers.

3. Participate in a study of the effects of urban and rural stormwater drainage on receiving waters' quality. Evaluate the feasibility, cost, and effectiveness of alternative drainage measures.
4. Investigate the possibility of providing a local clearinghouse service to local sewerage agencies for coordination of project reviews and issuance of construction and operating permits by the multitude of regulatory agencies in the Bay Area.
5. Investigate methods of providing emergency assistance, including operating services to local sewerage agencies in cases of catastrophe, material shortages, labor problems, and other emergency conditions.
6. Investigate the feasibility of a regional sludge disposal program.

Santa Clara Valley Water District

It is recommended that the Santa Clara Valley Water District pursue negotiations with the Bureau of Reclamation to acquire water from the San Felipe Project. It must be recognized that the Central Valley Basin (Basin 5) Water Quality Control Plan indicates a shortage of state waters for future needs, both in terms of local requirements and export demands. As the San Felipe Project waters originate from the Central Valley Water Project, a statewide shortage would obviously affect San Felipe Project contractors. It is, therefore, also recommended that investigations of potential use of reclaimed wastewater for groundwater recharge and the related public health concerns continue.

Surveillance

The effectiveness of a water quality control program cannot be judged without the information supplied by a strong and systematic surveillance and monitoring program. A detailed plan which calls for the establishment of such a surveillance and monitoring program is set forth in the Basin Plan.

An adequately designed surveillance and monitoring program will provide for the collection and

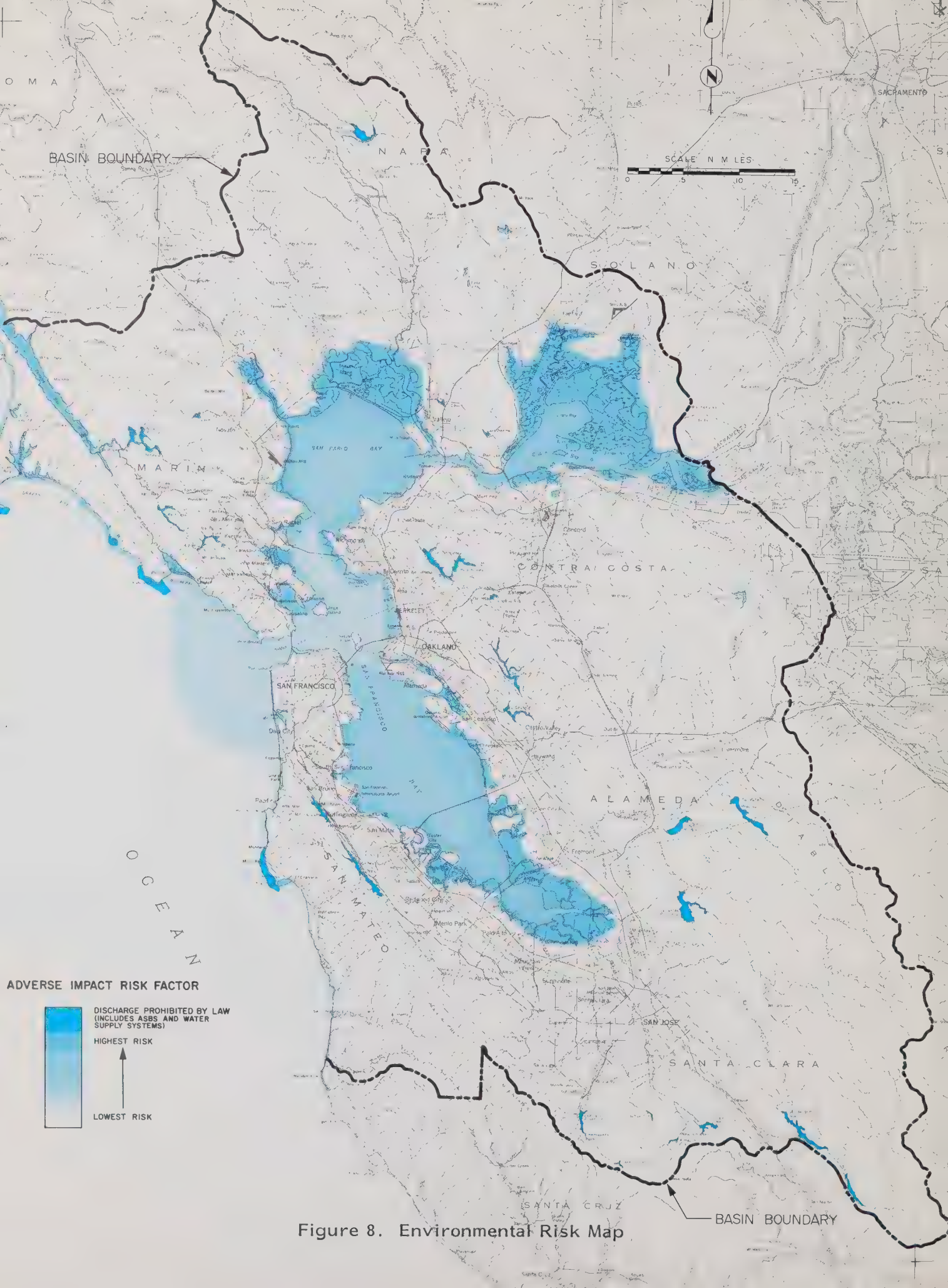


Figure 8. Environmental Risk Map

analysis of samples and the reporting of water quality data, storage of these data for rapid and systematic retrieval for subsequent use and the preparation of routine reports and data summaries. The taking of photographs and remote sensing of pollutant concentrations is included. The program to carry out the requirements in surveillance and monitoring is made up of ten elements:

1) Primary monitoring network, 2) discharger self-monitoring, 3) compliance monitoring, 4) intensive surveys, 5) nonpoint sources investigation, 6) aerial surveillance, 7) classification of inland lakes, 8) annual water quality inventory, 9) laboratory support and quality assurance, and 10) data storage, retrieval and reports.

THE RECOMMENDED PLAN ASSESSMENT

The environmental assessment for the Basin Plan is necessarily general in scope. Assessment of the recommended plan addresses itself to region-wide environmental issues and broad categories of potential environmental impact.

Emphasis has been placed on long-term effects of implementing the recommended plan, although indirect effects are covered as well. Primary effort has been directed toward identification of potential problem areas and potential impacts rather than on providing a detailed analysis of impact magnitude. Specific and detailed assessment is more appropriately undertaken at the project planning level for wastewater facilities.

Environmental Sensitivity

Environmental sensitivity to waste discharge is a key issue in the assessment of potential impacts associated with the recommended plan. By evaluating a set of "risk modifying variables" including: vulnerability of indigenous biological species to environmental change, density and diversity of species, trophic relationships, waste concentrations, and duration of exposure to harmful materials, followed by superimposing known environmental resources of the Bay Basin, a generalized environmental sensitivity map, as shown in Figure 8, was produced.

Zones of relative risk for harmful environmental effects from the discharge of wastewater pollutants are delineated. As concentrations of controllable pollutants will be kept within "safe" limits established by effluent standards and water

quality objectives, concern is primarily directed toward difficult to remove wastewater constituents such as heavy metals, pesticides and other stable organics whose potentially adverse biological effects are incompletely understood.

A comparison of Figure 8 with the recommended plan (Figure 7) reveals that the facilities plan intrudes less significantly into zones of higher risk than do present wastewater operations. Several major municipal discharges are removed from the highest risk zone and from freshwater streams. Exceptions include Fairfield and Livermore Valley where, during the wet season, effluent will be released to local receiving waters. Advanced treatment operations at Napa, Petaloma and Sonoma will initially allow discharge to local receiving waters year-round.

Four municipal systems will discharge to the second highest risk zone; those from the South Bay, Vallejo, Benicia and Central Contra Costa. Mathematical modeling results indicate that biota in this zone will not be exposed to adverse water quality conditions under "critical" steady state conditions.

Remaining discharges will be located in the lower three risk zones. Judgment, based upon the best available information, indicates that environmental problems are less likely to occur here than in the more sensitive zones. Environmental surveillance and monitoring will be required in all zones, but particularly in Zones 4 and 5, to ensure that any adverse accumulations of harmful constituents in the water, sediments or biota are detected, and appropriate corrective control actions taken.

Environmental Impact Assessment

At the basin planning level, the focus of the environmental assessment is on potential impacts with regional significance. Four general tools are used to weigh and discuss impacts:

- Beneficial uses
- Water quality objectives
- Predictions of water quality
- Estimates of the level of risk to environmental resources from planned actions.

Identification of the significant long-term impacts of the municipal wastewater management basin strategy conforms to the following order of topics: environmental risks associated with waste discharge to Basin waters, problems associated

BENEFICIAL USES OF RECEIVING WATERS



with specific wastewater constituents or characteristics, construction impacts, land and water use, geologic and hydrologic hazards, operational characteristics, accidents and safety, reclamation and reuse potential, energy use, social significance and aesthetics, and finally, population growth. Impacts within these categories are summarized in network format in Figure 9.

The "plan elements which generate impacts" are individual "components" of the wastewater management plan which constitute the source of environmental impacts. The impacts which are generated by these "elements" are read from the lower matrix of Figure 9. Specific "beneficial uses of receiving waters" in the Basin which will be impacted are read from the upper matrix.

Each individual impact "network" identifies potential environmental effects (initial and consequent-second and third order-condition changes) which may occur during the construction and operation of the proposed wastewater facilities. The separation of impacts into primary, secondary and third order conditions describes the chain of potential cause-condition-effect consequences which are generated by a particular "plan element."

Municipal wastewater treatment and disposal is but one facet of the comprehensive water quality control plan. Waste source management policies and controls are also assessed in terms of their environmental impact for the following categories: industrial wastewater management, sludge disposal, urban runoff management, agricultural wastewater management, individual dual treatment systems, and solid waste management.

Beneficial Effects

Adoption of the recommended plan as the future course of action to be taken in the Bay Basin provides certain major advantages. First, the plan represents a composite of programs which have already received careful study and acceptance at the subregional level and which could therefore proceed forward with a minimum of delay and duplicate effort. No severe adverse environmental impacts have been identified which could not be avoided or mitigated to an acceptable level by project design measures. Commitments of resources do not appear to foreclose future options involving reclamation and reuse. Further treatment improvements can be made in response to specific problems when they occur if surveillance

and assessment studies indicate that waste discharges are responsible. Adequate flexibility is retained to respond to changes in future population densities. Finally, and perhaps most importantly, no alternative strategy to the Basin Plan can be identified which is clearly superior or more viable from an economic, operational or environmental standpoint. Planning concepts which entailed significant departures from existing plans have unavoidable disadvantages which appeared to warrant their rejection. Therefore, no argument was discovered which clearly justified deviation from the present course of wastewater management planning.

The recommended facilities plan provides a balance between treatment of wastewaters to remove the maximum quantities of potentially harmful constituents and the transport of wastewaters and subsequent discharge to receiving water segments which provide greater dilution-assimilation capability. Attainment of recommended water quality objectives in the Bay system will provide protection for its varied biological resources. No unacceptable adverse impacts are anticipated with secondary treatment level wastewater discharge to the ocean in conformance with the State Ocean Plan.

Consolidation of sanitary districts within individual subregions should improve overall efficiency and reliability of treatment systems. Consolidation to a higher degree would probably not yield any significant additional advantages. The recommended plan does not call for construction of massive regional treatment facilities which require additional acreage of land. However, treatment plants are generally of sufficient size to permit the use of efficient rail systems to transport materials. Such modes of transport would not contribute noticeably to street traffic congestion nor significant air pollution. By balancing the need for centralization of facilities in areas of potential reclaimed water reuse markets with the need for provision of safe disposal points for "abnormal discharges," the prospect of implementing plans for future reclamation are improved.

The protection of beneficial water uses and the maintenance or enhancement of long-term productivity of the Bay system depends on proper management of freshwater and wastewater flows in the Basin. Implementation of the recommended Basin Plan provides the framework for long-term municipal wastewater management. It



also provides assurance that facilities will solve immediate problems and identifies studies that are needed to provide the information required for project design. Issues which will require additional study in the future include wastewater reclamation potential, land use management for water quality control, Central Valley water operations, and urban runoff management. The provision of secondary or higher level treatment together with the improved dispersion of wastewater constituents and the elimination of waste discharges to habitats exceptionally sensitive to waste loading combine to provide an aquatic environment of significantly higher quality than that of the past. The plan is expected to significantly improve long-term protection of biological resources that are a fundamental part of the social, economic, and aesthetic values associated with the Bay Area.

Adverse Effects

The recommended plan was selected on the basis of its superiority as measured against many criteria, not solely its environmental characteristics. For this reason some features of the Basin Plan may yield environmental impacts which cannot be entirely mitigated. Those obvious adverse impacts of the proposed Plan which cannot be avoided or reduced to an inconsequential level by recommended mitigation measures are summarized below:

The discharge to the Bay and ocean of heavy metals, pesticides, and other stable organics will continue and may increase despite upgraded treatment with some potential for adverse toxic effect of unknown dimension on aquatic biota.

The nonpoint or diffuse discharge of waste materials will continue to have an undetermined potential adverse impact on water and habitat quality.

Removal of wastewater discharge flows from the sloughs of the South Bay may result in reduction of brackish water marsh area with associated loss in food and shelter for surface feeding migratory waterfowl.

Adverse impacts, such as creation of dust, noise, traffic congestion, vegetation removal, loss of local habitats on facility sites, siltation, and inconvenience to nearby residents, can occur

during construction of wastewater management facilities in the Basin. In the estuarine environment, toxic substances sorbed on sediments can be resuspended during construction activities. Turbidity and siltation may occur resulting in potential adverse biological effects. Benthos may be disrupted and temporary losses or conversions in types of vegetation can occur on marshlands and open space crossed by pipelines.

Proposed treatment levels and increased waste loads will result in production of larger quantities of sludge wastes which must be processed, transported and either reused or disposed of in the Bay Area.

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